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SYSTEMATICS AND BIOLOGY OF MACQUARIE ISLAND ECHINODERMS

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Abstract

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Fifty-two echinoderm species are recorded from off Macquarie Island and the Macquarie Ridge in the Southern Ocean. One new asteroid *Odontohenricia anarea* sp. nov. and one new holothurian *Trachythyone nelladana* sp. nov. are described. The asteroid genus *Calvasterias* is synonymised with *Anasterias*. The asteroids *Cycethra macquariensis* and *Asterina hamiltoni* are synonymised with *Asterina frigida* and placed in the genus *Cycethra*. The asteroid *Ceramaster leimoxkingi* is synonymised with *C. patagonicus*, *Solaster dianae* with *S. notophrynus*, and *Anasterias sphoerulatus* with *A. mawsoni*. The asteroids *Psilaster charcoti*, *Odontaster penicillatus*, *Ceramaster patagonicus*, *Crossaster multispinus*, *Solaster notophrynus*, *Pteraster affinis*, *Henricia studeri*, the ophiuroid *Ophioplocus ineipiens*, and the holothurians *Paelopatides ovalis*, *Synallactes challengeri*, *Laetmogone* sp, *Taeniogyrus* sp are recorded from the island for the first time. The following species previously recorded from Macquarie Island have been re-identified: the asteroids *Odontaster aucklandensis (=O. penicillatus)*, *Henricia aucklandiae (=H. studeri)*, *Henricia lnkinsi (=H. obesa)*, *Smilasterias irregularis (=S. clarkailsa)*, *Anasterias antarctica (=A. directa)*, and the ophiuroid *Ophiacantha pentagona (= O. vilis)*. The existence at Macquarie Island of the species *Hymenaster* sp, *Goniocidaris umbraculum* and *Ocnus calcareus* require confirmation. The asteroids *Anasterias mawsoni*, *Pteraster affinis*, *Porania antarctica* and *Odontaster meridionalis* are reported from the shore around Heard Island. The ecology and relationships of echinoderms from Macquarie Island are discussed.

Introduction

Macquarie Island (54°29′S, 158°58′E) is in the Southern Ocean midway between Tasmania and the Victoria Quadrant of the Antarctic continent. The island is small (34 km long and to 5.5 km wide) and, together with small rocky outcrops to the north and south, lies on the central section of the Macquarie Ridge which runs south from New Zealand. This narrow ridge formed of Miocene basalt forms the southeast boundary of the Australian and Pacific tectonic plates, and Macquarie Island is a rare example of uplifted oceanic crust. (Williamson, 1988; Duncan and Varne, 1988; Selkirk et al., 1990). Recent evidence (Adamson et al., 1996) suggests that the ridge at Macquarie Island began its major phase of uplift approximately 5 mya and emerged around 700–600 kya. It has remained emerged for the six glacial/interglacial cycles since that time and experienced only periglacial rather than glacial activity.

The general ecology of Macquarie Island is determined to a great extent by its geographical position. The climate is typical of an isolated midlatitude island, and is characterised by strong winds, frequent storms and high rainfall (Streten, 1988). The water temperature usually varies from 4–7°C. The Antarctic convergence lies only 40 km to the southeast, and cold water can occasionally reach the island causing water temperatures to drop as low as 2.8°C (Williams, 1988). Nevertheless the island is the most southern ice-free shore in the eastern section of the Southern Ocean.

The first echinoderms from Macquarie Island to be reported in the scientific literature were collected by Augustus Hamilton over 2 weeks in March 1894. Hamilton, a biologist with the Otago University in New Zealand, travelled on the ketch *Gratitude* which was supplying a penguin oil industry on the island. He collected "... starfish, echinoderms and holothurians ..." from the eastern shore (Hamilton, 1895). The holothurians were described as a new species, *Psolus macquariensis*, by Dendy (1896) while he was Professor of Biology at the University of New Zealand. Specimens were sent to Europe where they were examined by Ludwig (1898) and Perrier (1905). Ludwig (1898) transferred the species to a new genus *Pseudopsolus*. One six-armed asteroid was identified as *Stichaster*

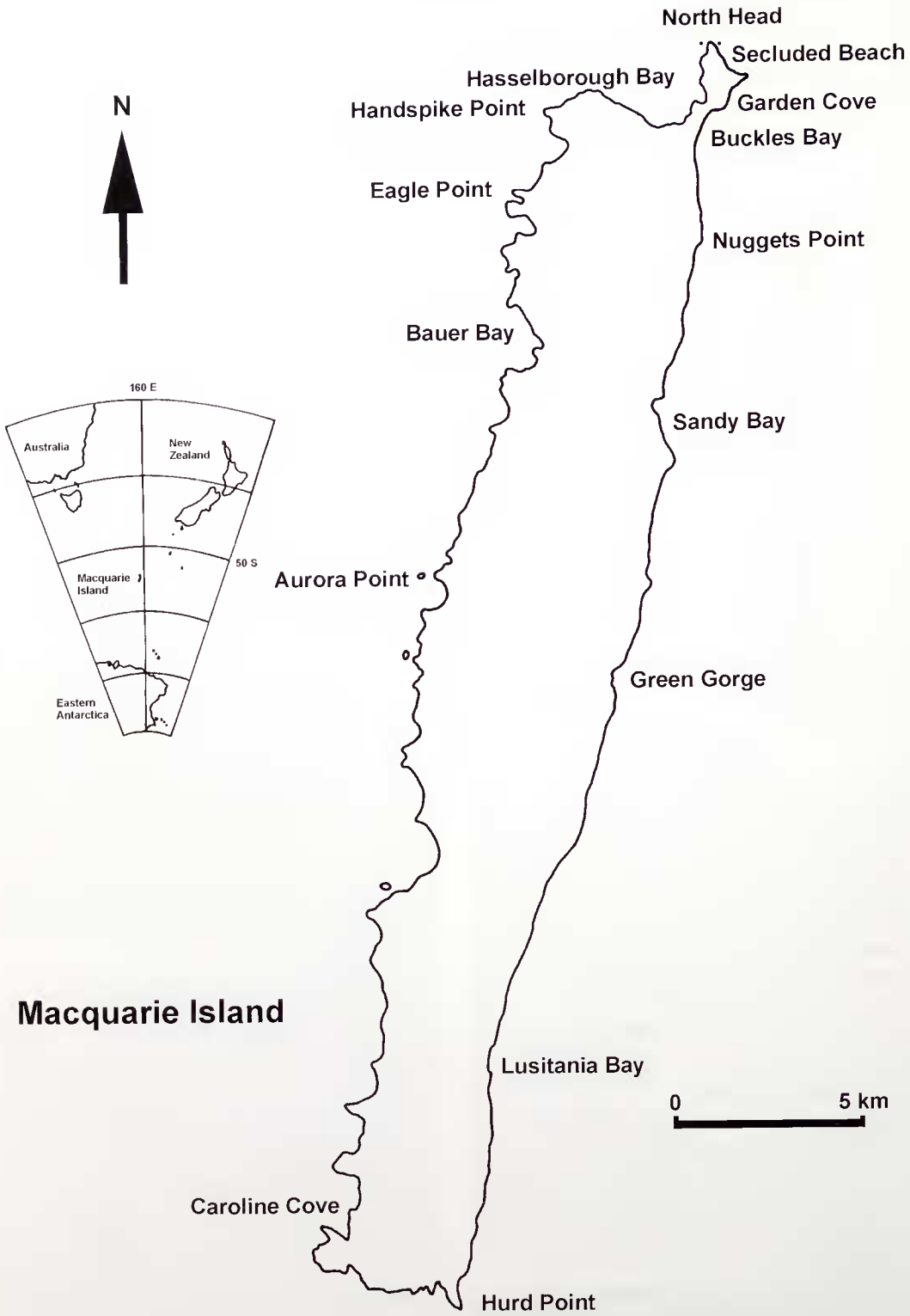

Figure 1. Macquarie Island, showing place names mentioned in the text and the position of the island in the Southern Ocean.

suteri by Benham (1909), but later provisionally referred to *Anasterias mawsoni* by Koehler (1920). Mortensen (1925) recorded a specimen of the New Zealand holothurian *Cucumaria (= Ocnus) brevidentis* var. *carnleyensis* collected by A. Hamilton but suspected that the locality label was incorrect, possibly swapped with the label in an equally aberrant lot of *Pseudopsolus macquariensis* supposedly collected by Benham from Stewart Island, New Zealand.

Harold Hamilton, son of A. Hamilton, spent several years surveying the biology of Macquarie Island as part of the Australasian Antarctic Expedition (AAE) of 1911–1914. Echinoderms were collected from various localities along the coast. From this material, Koehler (1920) described five new species of asteroid: *Parastichaster (=Anasterias) directus, P. mawsoni, P. sphoerulatus, Asterina hamiltoni (=Cycethra frigida) and Cycethra macquariensis (=Cycethra frigida)*, and recorded specimens of *Sporasterias (=Anasterias) antarctica* (herein referred to *Anasterias directa*). Mortensen (1921) and Koehler (1926) recorded specimens of the echinoid *Notechinus (=Pseudechinus) novaezealandiae*. Pawson (1968b) recorded the holothurians: *Pseudopsolus macquariensis, Trachythyone macphersonae, Pseudocnus laevigatus* and an unidentifiable species of *Trochodota* (herein provisionally referred to *Taeniogyrus dunedinensis*). No crinoids (A.H. Clark, 1937) or ophiuroids (Koehler, 1922b) were collected by the AAE expedition from Macquarie Island.

The British, Australian and New Zealand Antarctic Research Expedition (BANZARE) collected from several stations off Macquarie Island during 1–5 December 1930. Echinoderms were collected at station 81, from the shore at Buckles Bay, and dredged from station 83, off Lusitania Bay in 69 m. A.M. Clark (1962) recorded two asteroids from station 81: *Anasterias directa, A. sphoerulata*; three from station 83: *Henricia obesa, Hymenaster* sp., *Smilasterias* sp. cf. *irregularis (=S. clarkaitsa)*; and another two previously unrecorded specimens of *Anasterias mawsoni* and *Cycethra macquariensis* collected by the AAE. Madsen (1967) recorded four ophiuroids from station 83: *Ophiacantha pentagona* (herein referred to *O. vilis*), *Amphiura magellanica, Ophiura meridionalis*, and *phiopyren (=Ophioleuce) regulare*. No crinoids (John, 1939), echinoids (Mortensen, 1950) or holothurians (M. O'Loughlin, pers. comm.) appear to have been collected from Macquarie Island.

The Australian National Antarctic Research Expeditions (ANARE) founded a base on Macquarie Island in March 1948. A steady stream of biologists has visited or stayed at the base and systematically or sporadically collected specimens from the shoreline. Most collected predominantly around North Head, from Hasselborough to Buckles Bay. One exception was Wim Vestjens who surveyed many sections of the shoreline during 1961–1962. Reports based on this material have concentrated on the coastal ecology (Law and Burstall, 1956; Kenny and Haysom, 1962; Bennett, 1971; Simpson, 1976), biogeography (Edgar, 1987), reproduction (Simpson, 1982) and pollution (Smith and Simpson, 1995). Pawson (1962) described a new species *Trachythyone macphersonae* from a specimen collected by Hope Macpherson in 1959, and Pawson (1968b), reporting on some specimens collected by Isobel Bennett in 1967, recorded *Pseudocnus laevigatus* from the Island for the first time.

The New Zealand Oceanographic Institute (NZOI) dredged or trawled 47 benthic stations from Macquarie Island and the surrounding ridge between 1959 and 1965. Pawson (1968a) recorded *Psolus antarcticus, Trochodota dunedinensis* and *Pseudechinus novaezealandiae* from off Macquarie Island, and *Pseudocnus leoninoides* and *Goniocidaris umbraculum* from the northern Macquarie Ridge. McKnight (1973b, 1977) described three crinoids from this material, *Ptilocrinus* sp., *Metacrinus wyvillii* and *Comatulides (= Comissia) dawsoni*. McKnight (1984) finally provided an annotated checklist of the echinoderms from the survey. This included five crinoids, 14 asteroids, 11 ophiuroids, two echinoids and two holothurians.

The USS *Eltanin* also trawled several stations off Macquarie, as part of a large Southern Ocean research program. This included stations during cruise 16 (January 1965), cruise 27 (February 1967) and cruise 34 (June 1968). To date only data on the comatulid crinoids have been published; Speel and Dearborn (1983) listed three species from off Macquarie Island. The cidaroid echinoids have been the subject of an unpublished PhD thesis (F.J. Fell, 1976). In addition, some asteroids, echinoids and holothurians have been identified in the Smithsonian Institution (D. Pawson, pers. comm.), a few of which have been examined for this report.

The Australian Museum sponsored a general sublittoral survey of the Island during the summer of 1977–1978 (Lowry et al., 1978). Forty-one SCUBA dives were conducted at six different areas to a depth of 20 m. Several intertidal sites were also surveyed. This material has until now remained unidentified and unpublished. Another survey of the benthic and pelagic fauna was

conducted by ANARE between 6 and 10 December 1986 (Williams, 1988). Fish were the predominant target but many echinoderms were collected in the process. A new species of asteroid, *Smilasterias clarkailsa*, was described from this material (O'Loughlin and O'Hara, 1990). Finally, material was gathered from shallow water (0–3 m) by the author on a short visit to the island in November 1989.

Examination of material from these surveys indicated that the echinoderm fauna of Maequarie Island was imperfectly known. There are now 52 species recorded from Macquarie Island and the surrounding ridge, up from 44 known before this report. Two species are new and 11 species are recorded from the island for the first time. In addition, a revision of published material indicated that there are nine species that have either been erroneously identified or whose presence at Maequarie Island must be placed in doubt. The biogeography of Maequarie Island echinoderms has been discussed by O'Hara (1998a).

The following abbreviations are used. *Morphology*: d.d. - disc diameter (ophiuroids); dia - diameter; l/w - length over width; R - radius from centre of disc to arm tip (asteroids); r - radius from center to margin of disc (asteroids), ht - height; br - breadth (all measurements include skin covering unless stated).

Institutions: Museum Victoria, Melbourne (NMV); Australian Museum, Sydney (AM); South Australian Museum, Adelaide (SAM); Tasmanian Museum and Art Gallery, Hobart (TM); National Institute of Water and Atmospherie Researeh (formerly New Zealand Oceanographie Institute), Wellington (NIWA); the Natural History Museum, London (BMNH); National Museum of Natural History, Smithsonian Institution, Washington (USNM); Zoologisk Museum, University of Copenhagen (ZMUC).

Material examined. The bulk of material examined for this report was collected from Macquarie Island by the 1986 ANARE Maequarie Island biologieal trawl program (lodged in the NMV), the 1977–1978 Australian Museum Maequarie Island Expedition (AM) and various shore collections (NMV, AM, TM). The stations and material from the 1986 ANARE cruise is listed in Table 1. The station list (MA stations) for the 1977–1978 AM expedition (Lowry et al., 1978) is too large to reproduce here and the material has been included in Table 2. Historieal material examined includes specimens from the AAE (AM, BMNH), BANZARE (SAM, BMNH), NZOI (NIWA) and *Eltanin* (USNM) expeditions. This material was compared with numerous species from surrounding regions including Australia (AM, NMV), New Zealand (ZMUC, AM), Kerguelen (BMNH), Marion Island (AM), Heard Island (BMNH, NMV), South Ameriea (BMNH, ZMUC) and Antaretica (BMNH, AM, SAM, NMV). Comparative material is listed separately under each species below.

Phylum Echinodermata

Class Crinoidea

Key to Macquarie Island Crinoidea

1.	Stem present	2
—	Stem absent	3
2.	Stem without cirri, stem terminates in a basal disk	*Ptilocrinus* sp.[a]
—	Stem bearing cirri at regular intervals	*Metacrinus wyvillii*[b]
3.	Usually more than ten arms	4
	Ten arms only	5
4.	Oral pinnules flexible, usually with more than 30 segments. Arms rounded or square with smooth sides at the arm base, 11–20 arms. Cirri stout, with fewer than 25 segments	*Glyptometra inaequalis*[c]
—	Oral pinnule prismatie, oral pinnules with less than 15 segments. Arms laterally compressed, with spinous median keel near the base of the arm, 10–13 arms. Cirri long and slender, with more than 25 segments	*Daidalometra arachnoides*[d]
5.	Auxiliaries and seeond braehials with prominent proximal lobes, whieh ineise the neighbouring ossieles	*Florometra austini*
—	Auxiliaries and seeond braehials proximally truneate	6
6.	Oral pinnules with short segments, as long as wide, toothed distal segments forming a rudimentary comb	*Comissia dawsoni*[e]
—	Oral pinnules with long and slender segments, to three times as long as wide	*Antedonid* sp.[f]

Notes on key:

[a] McKnight (1973b: 204; 1984: 141) recorded ossicles of a stalked crinoid, possibly of the genus *Ptilocrinus*, from the southern Macquarie Ridge (NZOI stn D5, 56°40.6′S, 158°45.5′E, 1280 m). McKnight noted that it was probably related to *P. antarcticus* Bather, a deep-water Southern Ocean species.

[b] McKnight (1973b: 202; 1984: 141) recorded a single fragmented specimen of *M. wyvillii* Carpenter, 1884 from the Northern Macquarie Ridge (NZOI stn D159, 49°01′S, 164°30′E, 741 m). This species otherwise been found in deep-water Pacific localities.

[c] McKnight (1984: 141) and Speel and Dearborn (1983: 24–25) recorded *G. inaequalis* (Carpenter, 1888) from off Macquarie Island and off the northern Macquarie Ridge (682–1693 m). This species otherwise occurs throughout the Southern and South Pacific Oceans.

[d] Speel and Dearborn (1983: 22–24) recorded a single specimen of *D. arachnoides* (A.H. Clark, 1909) to the northeast of Macquarie Island in 1647–1665 m. This species has been otherwise recorded from the tropical western Pacific Ocean (22–118 m) and near Auckland Island south of New Zealand (952–1336 m).

[e] McKnight (1977: 99–100, fig. 7–9; 1984: 141) recorded 15 specimens of *C. dawsoni* (McKnight, 1977) from the northern Macquarie Ridge (NZOI stn D18, 52°31′S, 160°31′E, 128 m). This species was originally described as *Comatulides dawsoni* but transferred to *Comissia* by Hoggett and Rowe (1986: 121). This comasterid is unusual in having a central mouth and 10 arms. It has otherwise been found from three localities on the Campbell Plateau, south of New Zealand (128–1280 m).

[f] Speel and Dearborn (1983: 52) recorded four specimens of "Unidentified Antedonid species B" from two *Eltanin* stations off Macquarie and Auckland Islands (750–996 m). They note that A.M. Clark, who examined the specimens, was uncertain of their affinities within the family Antedonidae.

Table 1. Echinoderms from ANARE Macquarie Island benthic trawl stations, December 1986

BT1, off Lusitania Bay, 54°44.0′S, 158°51.4′E, 3541 m, 6 Dec 1986
No echinoderms.

BT2, off Lusitania Bay, 54°43.5′S, 158°53.1′E, 100–105 m, 6 Dec 1986
Odontaster penicillatus, Porania antarctica, Henricia studeri, Henricia obesa, Smilasterias clarkailsa, Amphiura magellanica, Pseudechinus novaezealandiae, Psolus neozelanicus, Pseudocnus laevigatus, Trachythyone macphersonae

BT3, off Nuggets Point, 54°33.4′S, 158°56.9′E, 108–135 m, 8 Dec 1986
Florometra austini, Odontaster penicillatus, Ceramaster patagonicus, Henricia studeri, Henricia obesa, Smilasterias clarkailsa, Ophiacantha vilis, Amphiura magellanica, Ophiura meridionalis, Pseudechinus novaezealandiae, Psolus neozelanicus, Trachythyone nelladana sp. nov., *Pseudocnus laevigatus, Trachythyone macphersonae*

BT4, off Lusitania Bay, 54°45.0′S, 158°52.3′E, 65–90 m, 9 Dec 1986
Odontaster penicillatus, Porania antarctica, Henricia studeri, Henricia obesa, Amphiura magellanica, Ophioleuce regulare, Pseudechinus novaezealandiae, Pseudocnus laevigatus, Trachythyone macphersonae, Taeniogyrus dunedinensis

BT5, off Lusitania Bay, 54°44.2′S, 158°52.3′E, 57–70 m, 9 Dec 1986
Henricia studeri, Henricia obesa, Amphiura magellanica, Pseudocnus laevigatus

BT6, off Lusitania Bay, 54°43.4′S, 158°52.1′E, 25–29 m, 9 Dec 1986
Psilaster charcoti, Ophioplocus incipiens, Pseudechinus novaezealandiae

BT7, off Eagle Point, 54°31.4′S, 158°50.8′E, 150–200 m, 10 Dec 1986
Amphiura magellanica

BT8, off Handspike Point, 54°29.7′S 158°51.2′E, 330–450 m, 10 Dec 1986
Henricia studeri, Solaster notophrynus., Crossaster multispinus, Amphiura magellanica, Ophiura (Ophiuroglypha) irrorata

BT10, off Judge and Clerk Rocks, 54°23.6′S, 158°59.3′E, 100 m, 10 Dec 1986
Odontaster penicillatus., Henricia studeri, Henricia obesa, Odontohenricia anarea sp. nov., *Ophiacantha vilis, Pseudechinus novaezealandiae*

Table 2. Distribution of shallow water echinoderms around Macquarie Island (0–20 m)

	Anasterias directa	*Anasterias mawsoni*	*Cycethra frigida*	*Pseudechinus novaezealandiae*	*Ophiacantha vilis*	*Pseudopsolus macquariensis*	*Trachythyone macphersonae*	*Pseudocnus laevigatus*	
North Head	x	x							
Gorilla Head Rock	x	x	x	x				x	
Tottan Head, Goat Bay	x	x	x	x	x		x	x	
Secluded Beach	x	x	x			x			
Tern Rock Bay	x	x		x		x	x	x	
Garden Cove and Hayter Rock	x	x	x	x	x	x	x	x	*Smilasterias clarkailsa* *Taeniogyrus dunedinensis*
Buckles Bay	x	x		x	x	x	x	x	*Amphiura magellanica*
Nuggets Point	x	x					x		
Sandy Bay	x	x		x			x	x	*Henricia obesa*
Green Gorge	x	x	x	x		x	x	x	*Taeniogyrus* sp.
Lusitania Bay	x	x							
Hurd Point	x								
Caroline Cove	x	x	x	x	x		x	x	*Porania antarctica* *Henricia obesa* *Pteraster affinis* *Smilasterias clarkailsa*
Aurora Point	x								
Bauer Bay	x					x			
Handspike Point	x		x				x	x	
Hasselborough Bay	x	x				x			
Aerial Cove	x	x	x	x	x	x	x	x	
Anchor Rock	x	x	x				x	x	

Order Comatulida

Antedonidae

Florometra anstini A.M. Clark

Plate 3k

Florometra sp.—A.M. Clark, 1966: 704.
Florometra austini A.M. Clark in A.H. Clark and A.M. Clark, 1967: 324, fig. 16.—Speel and Dearborn, 1983: 29, fig. 3, tbl. 6.—McKnight, 1984: 141.

Material examined. ANARE 1986 Expedition, BT3, NMV F60300(1).

Description of material. Centrodorsal hemispherical, 1.8 mm dia, 1.0 mm high; approximately 70 eirri (mostly broken), cirrus sockets in alternating rows, remaining cirri with 13–16 segments, proximal 2 segments wider than long, middle segments 2.5 times longer than wide, slightly waisted, distal rim slightly everted, distal segments just longer than wide, terminal claw and opposing spine well developed. 10 arms, all broken; 5 radials, $1Br_1$ very short, auxiliaries eruciform, proximal lobe (synarthial tubercle) overlying $1Br_1$, second brachial also with proximal synarthial tubercle that overlies Br_1, succeeding brachials wedge shaped, with slightly everted distal edges. First syzygy at 3+4, second at 9+10, length between $1Br_1$ to second syzygy 4 mm. P_1 and P_a very long, to 6 mm, approx 25 segments, proximal segments longer than wide, distal segments small, as long as wide, with low dorsal tubercles, pinnule appearing comb-like. P_2, the first genital pinnule, with 12 segments, 2 proximal segments small, as long as wide, next 7 segments enlarged and widened, 2–3 times as long as wide, bearing the gonad, distal segments slender, with spinous distal edges. Similar genital pinnules present until P_7. Disc naked, mouth central, anal cone eccentric, high and slender.

Colour. Macquarie specimen (in alcohol) with white arms and centrodorsal, brown disc and gonads.

Habitat. A.M. Clark (1966) records this species from a bryozoa/sponge substrate.

Distribution. Cook Strait, New Zealand (192–550 m); off Campbell and Antipodes Islands (58–210 m); Macquarie Island and the Macquarie Ridge (108–135 m).

Remarks. The eirri and pinnules P_1 and P_a on this specimen have far fewer segments than was reported for the type series. Possibly this can be attributed to the larger size of the types (centrodorsal = 4.0–5.5 mm dia). In this species P_2 is usually similar to P_1, long and flagellate with many segments. P_3 is usually the first genital pinnule, however, P_2 or P_4 can occasionally be the first to bear a gonad. This species was previously known from Macquarie Island only from fragments.

Class Asteroidea

Key to Maequarie Island Asteroidea

(modified from A.M. Clark, 1962)

1.	2 series of tube feet in each arm furrow. Pedicellariae rare (except *Ceramaster*)	2
—	4 series of tube feet in each arm furrow. Straight and crossed pedicellariae common	15
2.	Marginal arm plates large and conspicuous, forming a continuous rim around the disc and arms	3
—	Marginal arm plates small, usually inconspicuous, often similar to abactinal plates	6
3.	Tube feet pointed, lacking suckers	*Psilaster charcoti*
—	Tube feet with sucking disks	4
4.	Stellate form, arms long and pointed	*Pseudarchaster* sp.[a]
—	Subpentagonal form	5
5.	Large conspicuous recurved oral spine at the apex of each jaw	*Odonaster pencillatus*
—	Several blunt tipped oral spines around the jaw margin. Pedicellariae present with large flat valves	*Ceramaster patagonicus*
6.	Disc covered in a thick skin and low sparse tubules. 5 short arms. Ventral disc surface without spines, covered in radial striations	*Porania antarctica*
—	Not as above	7

7. Abactinal plates with a median pillar (pedicel) which bears crown of spinelets (paxillae) 8
— Abactinal plates flat or slightly convex, bearing spines or granules. No paxillae 12
8. Abactinal surface roofed over by a membrane supported by elongate paxillar spines forming a chamber. 5 arms, with a conspicuous webbed actinolateral fringe of spines 9
— Abactinal paxillae free of a membrane covered chamber. 7–11 arms 11
9. Adambulacral spines not webbed ..... *Hymenaster* sp.[b]
— Adambulacral spines webbed 10
10. Oral spines not webbed ..... *Pteraster stellifer*[b]
— Oral spines webbed ..... *Pteraster affinis*
11. Abactinal paxillae with short spines and arranged in regular oblique rows. 7 arms ..... *Solaster notophrynus*
— Abactinal paxillae with long penicillate spines and arranged in an irregular reticulum. 9–11 arms ..... *Crossaster multispinus*
12. Subpentagonal form. 5 short triangular arms. Dorsal side convex, ventral side flat ..... *Cycethra frigida*
— Disk small, 5 long slender subcylindrical arms. 1–2 sabre-shaped adambulacral spines deep in arm furrow 13
13. Large recurved oral spine at each jaw tip ..... *Odontohenricia anarea* sp. nov
— Several small oral spines around the jaw margin 14
14. Abactinal spinelets small and numerous, up to 30 per plate ..... *Henricia studeri*
— Abactinal spinelets stout and spaced, up to 6 per plate ..... *Henricia obesa*
15. 2 or more spines on each adambulacral plate 16
— 1 spine on each adambulacral plate 17
16. 1 longitudinal dorsolateral series of spines ..... *Sclerasterias mollis*[c]
— Numerous dorsolateral spinelets ..... *Smilasterias clarkailsa*
17. 5 arms ..... *Anasterias directa*
— 6 arms ..... *Anasterias mawsoni*

Notes on key:

[a] McKnight (1984: 141) recorded a juvenile specimen of a *Pseudarchaster* species from off Macquarie Island (NZOI stn C734, 53°55′S, 158°55′E, 360 m). McKnight noted its close similarity to *P. abernethyi* H.B. Fell, 1958 from New Zealand. Another species *P. discus* Sladen, 1889 occurs off South America and Marion Island.

[b] A.M. Clark (1962: 67) recorded a juvenile *Hymenaster* specimen from BANZARE station 69 off Lusitania Bay, and McKnight (1984: 143) recorded a specimen of *Pteraster stellifer* Sladen, 1889 from Macquarie Island (NZOI stn C734, 53°55′S, 158°55′E, 360 m). Both these specimens are discussed under *Pteraster affinis*.

[c] McKnight (1984: 143) recorded two specimens of *S. mollis* (Hutton, 1872) from the northern Macquarie Ridge (NZOI stn D20, 49°39.8′S, 164°02.2′E, 126 m). *S mollis* is otherwise known from the South Island of New Zealand and the Chatham Islands, 22–697 m.

Order Paxillosida

Astropectinidae

Psilaster charcoti (Koehler)

Plate 1a

Ripaster charcoti Kochler, 1906: 4–6, pl. III figs 20, 21, 31, 32.—Koehler, 1920: 258–259, pl. LI fig. 5, pl. LII fig. 1, pl. LXXII fig. 1.

Psilaster charcoti.—Fisher, 1940: 93–94.—A.M. Clark, 1962: 13.—H.E.S. Clark, 1963: 30–31, text-fig. 4, pl. 3 figs 7–8. —A.M. Clark, 1989: 290.

Material examined. Macquarie Island, ANARE 1986 Expedition, BT6, NMV F60274(1); Antarctica, 65° 42′S, 92° 10′E, 110 m, 21 Jan 1914, AAE stn.7, identified by Koehler (1920), AM(1); MacRobertson Land, 66° 45′S, 62° 03′E, 219 m, BANZARE stn 107, K1400(2).

Comparative material examined. Psilaster acuminatus Sladen, 1889: Australia, eastern Bass Strait, 38° 23′S, 148° 46′E, 448–460 m, 5 May 1984, NMV F82984(1).

Description of Macquarie Island material. R = 50 mm, r = 11 mm; 5 arms, flattened, tapered evenly to narrow point, 2 arms bent back over disc. Disc

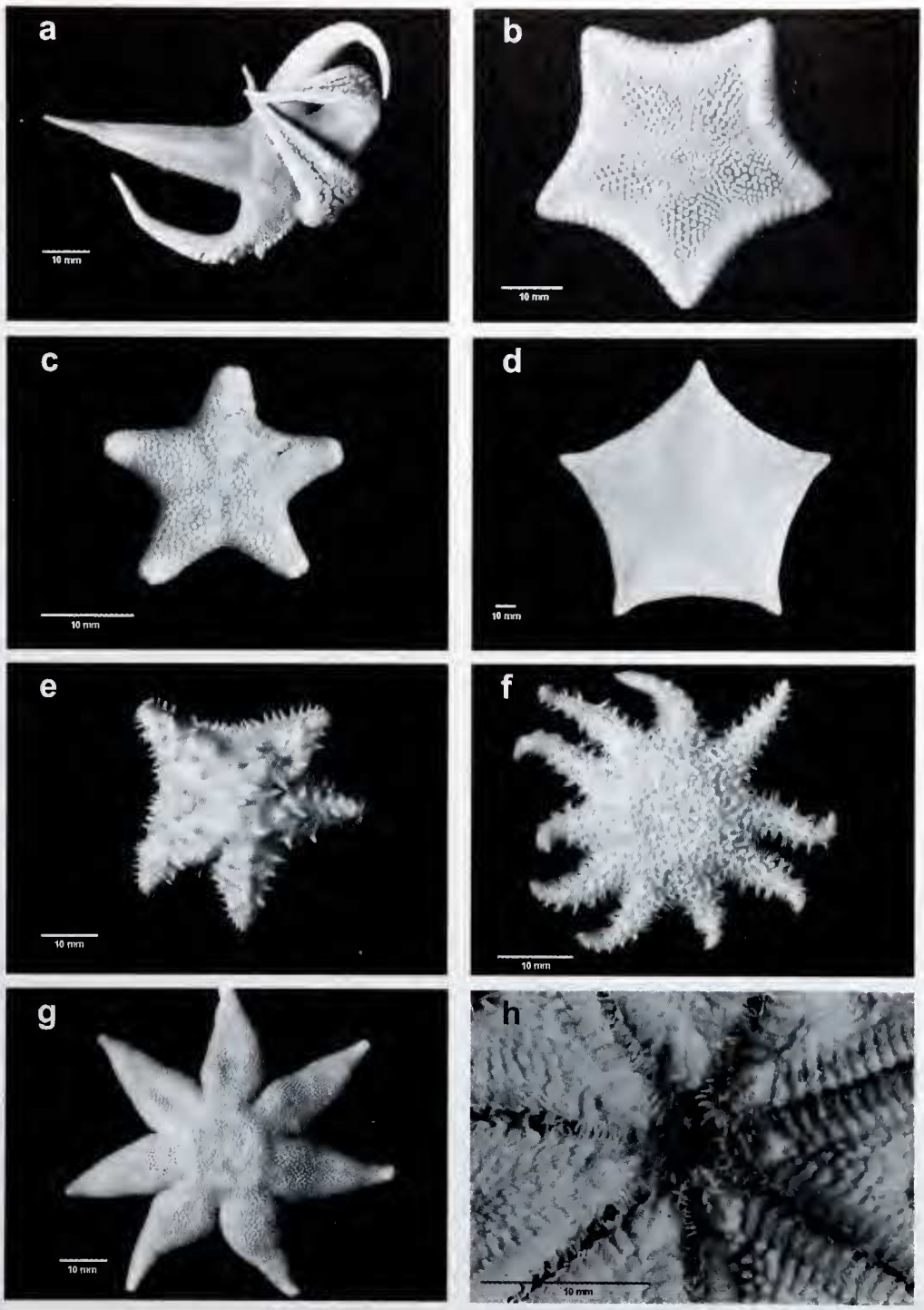

Plate 1. a, *Psilaster charcoti*, dorsal view (lower arm slightly damaged on margin), NMV F60724; b, *Odontaster penicillatus*, dorsal view, NMV F60276; c, *Cycethra frigida*, dorsal view (disc slightly damaged on upper right), NMV F76227; d, *Ceramaster patagonicus*, dorsal view, NMV F76237; e, *Porania antarctica*, dorsal view, NMV F60278; f, *Crossaster multispinus*, dorsal view, NMV F60291; g, *Solaster notophrynus*, dorsal view (skin removed from arm on left), NMV F60290; h, *Solaster notophrynus*, oral view, NMV F60290.

with central epiproctal cone and exposed madreporite. Abactinal plates in close uniform reticulum, lobed, with narrow bars connecting up to 6 neighbouring plates. Plates paxillate with high narrow pedicel, widened at tip, bearing 4–9 short spinelets. Papular areas small, each with 1 papula. Marginals prominent, lateral in position, up to 50 along arm, protrudent with fascioles between plates, superomarginals slightly smaller than inferomarginals, plates covered by numerous small thin spinelets, some capitate, some serrate, with transverse row of large flattened pointed spines in centre of plate, up to 4 on superomarginals extending to next plate, up to 4 larger spines on inferomarginals, extending in length over 2 plates, to 3.0 mm long. Up to 5 series of actinals on interradial area of disc, only 1 persists beyond fifth marginal plate, to at least three-quarters R, plates small, convex, more numerous than adambulacrals, paxillate with 3–10 small conical subequal spinelets, often convergent. Adambulacrals with 3–4 long angular pointed furrow spines, central spine longest, to 2.0 mm, up to 6 clustered subambulacral spines, proximal pair of plates laterally compressed with no furrow spines. Oral plates elongated, tumid, projecting into mouth, with 2 rows of spines on either side of the plate, furrow row with 10–12 thick blunt spines, innermost 1–2 enlarged, up to 6 suboral spines. Furrow narrow, 2 series of pointed tube feet without suckers. Ventral surface covered in gelatinous material that obscures spines.

Reproduction. This species develops lecithotrophic swimming non-feeding larvae; egg size varies from 0.77 mm (Arthur Harbour, Scotia Arc) to 0.95 mm dia (McMurdo Sound) (Pearse and Bosch, 1994).

Colour. Macquarie Island specimens (in alcohol) light tan. Falkland Island specimens coloured pink dorsally, sometimes purple in the disc centre and yellow ventrally (Fisher, 1940). Antarctic specimens reddish brown or brown yellow (Koehler, 1912).

Habitat. Usually mud, sometimes with pebbles, rock (Fisher, 1940) or sponge/bryozoa (H.E.S. Clark, 1963).

Distribution. Circumpolar Antarctic, South Georgia, Bouvet Island (30–3248 m); Macquarie Island (25–29 m).

Remarks. The Macquarie specimen closely matches the descriptions and figures of Koehler (1906, 1920) and H.E.S Clark (1963). I have compared it to Antarctic specimens identified by Koehler (1920) and A.M. Clark (1962). These are similar although larger specimens (R > 90 mm) differ in having more numerous spines, 8–12 abactinal spinelets, 5 superomarginal spines, 5 inferomarginal spines, and subequal oral spines. H.E.S. Clark (1963) recorded paxillate pedicellariae on her Ross Sea specimens. These are absent from the current specimens.

A similar species, *P. acuminatus* Sladen, 1889, is known from off Australia, New Zealand and South Africa. An Australian specimen in Museum Victoria was examined for comparison. It differs in having larger marginal plates, fewer spines on the inferomarginals, rare or absent superomarginal spines, and larger abactinal paxillae. *Proserpinaster neozelanicus* (Mortensen, 1925), another superficially similar species from New Zealand, differs in having larger marginal plates which extend onto the dorsal surface, 2 rows of larger spines on inferomarginal plates and 2 series of actinal plates persisting along the arm length. *Bathybiaster loripes* Sladen, 1889, a wide ranging Southern Ocean astropectinid, has smaller enlarged spines on the marginal plates and a mixture of large and small spinelets on the abactinal paxillae.

P. charcoti is a new record for Macquarie Island. It is has previously been recorded only in Antarctic waters.

Order Valvatida

Odontasteridae

Odontaster penicillatus (Philippi)

Plate 1b

Goniodiscus penicillatus Philippi, 1870: 268.

Odontaster penicillatus.—Fisher, 1940: 105–109.—A.M. Clark and Downey, 1992: 156–157, figs 24i–j, 26n–p, pl. 37b [full synonymy].—A.M. Clark, 1993: 197.

Odontaster aucklandensis.—McKnight, 1984: 141 [non *O. aucklandensis* McKnight, 1973c].

Material examined. Macquarie Island, off Buckles Bay, 372 m, Feb 1967, NMV F60275(1). ANARE 1986 Expedition, BT2, NMV F60277(1); BT3, NMV F60276(2); BT4, NMV F76225(2); BT10, NMV F60313(1).

Falkland Islands, *Discovery* stns WS73, WS93, WS824, WS848, 115–130 m, identified by Fisher (1940), BMNH 1948.3.16.237,264,274,277.

Argentina, Buenos Aires, 38°25′S, 56°30′W, identified Bernasconi, BMNH, 1960.9.1.1(1).

Comparative specimens examined. O. meridionalis (Smith, 1876): Heard Island, Camp Beach, washed up after storm, NMV F76234(8); Counthian Beach, 7 Jun 1951, NMV F76235(4); S.W Beach, 1 Aug 1951, NMV

F76236(6); *O. penicillatus grayi* (Bell, 1881): Punta Arenas, Sandy Point, HMS *Alert*, 17–19 m, BMNH (holotype). *Odontaster benhami* Mortensen, 1925: New Zealand, Oamaru, 37–55 m, 1960, AM J7067(4).

Description of Macquarie Island material. R = 16 to 50 mm, r to 28 mm. Disc flat, subpentagonal with slightly concave margins. Abactinal disc plates tabulate, with 4–18 spinelets, peripheral spinelets slightly more pronounced. Spinelets on largest specimen granule-like, truncate, as wide as high, some with angular edges; spinelets on smaller specimens terminating in small glassy thorns. Up to 25 plates between margin and disc centre. Papulae present between tabulae on disc and radial areas. Large tumid marginal plates fringe body margin, 35 plates from arm tip to arm tip on largest specimen, 18–19 when R = 23 mm, with up to 300 spinelets per plate, similar in form to abactinal spinelets, slightly longer on inferomarginal plates. Actinal plates convex, to 10 rows, with 5–12 spinelets; spinelets near mouth long, bluntly pointed, 3–4 times as high as wide, up to 1.1 mm high, orientated distally; marginal spinelets shorter, more granular and less numerous. No actinal papulae. Adambulacral plates with 6–12 spines in 2 transverse rows, 2–3 spines nearest furrow longest, up to 1.6 mm, cylindrical or slightly flattened, blunt tips, spines decreasing in length away from furrow. 1 (rarely 2) large recurved oral spines at the jaw tip, orientated distally, with pointed glassy tip, on largest specimen 4 mm long, with slightly keeled ventral midline, up to 2 mm long when R = 23 mm. 2 series of suckered tube feet. No pedicellariae.

Colour. Macquarie Island specimens (in alcohol) light tan. Live Atlantic specimens greyish, orange, yellow or brown (A.M. Clark and Downey, 1992).

Habitat. Sand, coarse shell and pebbles, mud (A.M. Clark and Downey, 1992); rock (Branch et al., 1993).

Distribution. Southern South America, Falkland Islands, Burwood Bank (8–350 m); Marion Island (527 m); Macquarie Island (55–372 m).

Remarks. As noted in the description, the largest Macquarie Island specimen differs from the smaller specimens in the form of the abactinal spinelets. There is a similar range of variation in the abactinal spinelets on specimens of *O. penicillatus* I have examined from South America. The number of spinelets can reach 50 per paxillae (BMNH, 1948.3.16.277) and the shape can vary from squat, capitate with a thorny apex to long, tapering and serrated. Specimens of *O. meridionalis* (Smith, 1876) from Heard Island also vary in the form of the abactinal spinelets, with only some having glassy tips. Conversely, the presence of pointed glassy tips on the abactinal spinelets has been used to distinguish the New Zealand species *O. benhami* Mortensen, 1925 from the subantarctic New Zealand species *O. aucklandensis* McKnight, 1973c.

The Macquarie specimens are provisionally referred to the polymorphic species *O. penicillatus*. This species varies from stellate in form with numerous small marginal plates to subpentagonal with fewer larger marginal plates (Fisher, 1940; A.M. Clark and Downey, 1992). Subpentagonal forms from the Magellanic region have been named *O. penicillatus grayi* (Bell, 1881). This subspecies differs from the Macquarie specimens in possessing pedicellariae (Mortensen, 1925). McKnight (1984) referred his Macquarie Island material to *O. aucklandensis* but the present specimens (from Macquarie Island and South America) lack the distinctive glassy granules that occur on the abactinal tabulae of the New Zealand species *O. aucklandensis* and *O. benhami*.

Ganeriidae

Cycethra frigida (Koehler) comb. nov.

Plate 1e, Figure 2

Asterina frigida Koehler, 1917: 46–48, pl. 6 figs 9–11, pl. 7 fig. 8.—Madsen, 1955: 13.—A.M. Clark, 1962: 33.—Guille, 1974: 34.—Cherbonnier and Guille, 1975: 615.—A.M. Clark, 1993: 209.

Asterina hamiltoni Koehler, 1920: 133–136, pl. 35 figs 5–7, 10, pl. 36 figs 1–3, pl. 66 fig. 5.—A.M. Clark, 1962: 24.—Bennett, 1971, pl. 56 fig. 4.—Rowe and Pawson, 1977: 343.—A.M. Clark, 1993: 210.—O'Hara, 1998a: 146. [new synonymy]

Cycethra macquariensis Koehler, 1920: 139–142, pl. 34 figs 1–4, 6, 7, pl. 66 figs 5a, b.—A.M. Clark, 1962: 24–25.—Rowe and Pawson, 1977: 345.—Simpson, 1982: 45.—McKnight, 1984: 142.—A.M. Clark, 1993: 200. [new synonymy]

Material examined. Macquarie Island, no date, AM J3520(holotype of *A. hamiltoni*); 10 Oct 1913, AM J3605(holotype of *C. macquariensis*); AAE expedition, BMNH, 1965.8.5.27(1); Secluded Beach, 27 Nov 1989, NMV F76232(2); NMV F76233(3); Garden Cove, 21 Aug 1952, NMV F75925(1); 31 Mar. 1962, NMV F45113(3); 12 Aug 1962, NMV F45112(1); no date, NMV F45008(1); 25 Nov 1989, 0.5–1m, NMV F76229(1); NMV F76230(2); NMV F76231(3); 26 Nov 1989, NMV F76227(5); Aerial Cove, 26 Jan 1950, NMV F75924(1); 28 Nov 1989, NMV F76228(3). AM 1977–1978 Expedition, Gorilla Head Rock (9–12 m), MA-142(2), MA-145(1), MA-149(3); Tottan Head, Goat Bay (9–14 m), MA-39(1), MA-41(2), MA-42(1), MA-371(5), MA-374(8), MA-376(3); Garden Cove (6–14 m), MA-87(1), MA-92(1), MA-124(3),

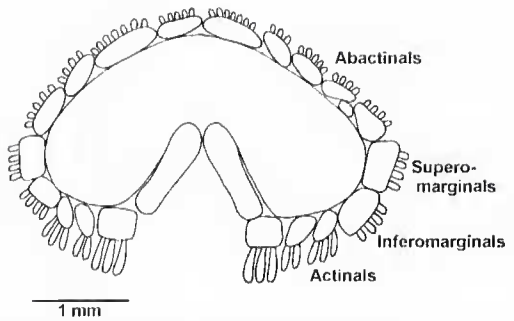

Figure 2. *Cycethra frigida*, NMV F76231, schematic diagram of an arm cross section showing the position of the skeletal plates and the absence of internal struts.

MA-125(2), MA-127(3), MA-128(3), MA-350(1), MA-379(8); Green Gorge (14–18 m), MA-245(4), MA-251(2); Caroline Cove (8–13 m), MA-300(1), MA-306(3); Handspike Point (intertidal), MA-136(4); Aerial Cove (3-6 m), MA-47(3), MA-85(3), MA-98(1), MA-100(1), MA-107(13), MA-108(8), MA-109(7), MA-110(2), MA-382(8), MA-386(6), MA-387(1), MA-388(4), MA-389(2); Anchor Rock (20 m), MA-89(2).

Kerguelen, NW end of Long Island, BANZARE stn 56A, identified by A.M. Clark (1962), BMNH, 1965.8.5.48(2); Jeanne d'Arc, 20 m, BANZARE stn 5, SAM K1420(1); BANZARE collection 784, littoral, SAM K1421(3); Gazelle Basin, 25–28 Dec 1898, *Valdivia* stn 160, identified by Madsen (1955), ZMUC(1).

Description of Macquarie Island material. R to 20 mm, r to 9 mm, disc higher than arms, ventral, dorsal surfaces mostly flat, often small sunken areas on dorsal interradius; 5 arms (1 specimen with 4 arms, NMV F76233), short but distinct, dorsally convex, ventrally flattened , wide at base, tapering blunt, rounded tip. Madreporite halfway to interradial margin; anus sometimes visible centrally; 2 gonopores sometimes visible on mid-actinal area. Abactinal plates cruciform, stellar, triangular or irregularly-shaped, with low convex 'Y'-shaped or broadly-cresentic thickened region bearing spinelets, rest of plate flat, thin, imbricating with 3–5 neighbouring plates; some small round secondary plates in papular areas. Plates irregularly arranged. Papular areas small, no larger than plate with 1, rarely 2, papulae. Abactinal spinelets in round or oval cluster, 4–36, usually 10–20 per plate. Spinelets short, blunt, terminally spiniferous, l/w = 2–2.5 (up to 3 when cleaned of skin, with constricted waist in middle). Spinelet clusters obscuring underlying network of plates.

Superomarginal plates larger than abactinals, lateral or ventral position on disc, lateral on arms, convex, 35 plates from arm tip to arm tip on R = 17 mm, proximal plates oval, 2–2.5 times as high as wide, orientated transversely, plates placed obliquely near arm base and on arm, plates on arm 1–1.5 times as high as wide. Inferomarginals oval, convex, 1–1.5 times as high as wide, slightly oblique on arms. Marginal spinelets as abactinals, 2 transverse rows on proximal plates with up to 7 spinelets in each row, 3 rows or cluster on distal plates. Actinals block-like, rectangular, in an imbricating lattice, up to 10 plates from margin to jaw; distal plates shorter; forming longitudinal rows near the furrow, distal plates irregular or in irregular transverse rows; 2 of the longitudinal rows persist onto the arms, one to tip. No actinal papulae. Actinal spinelets longer than abactinals, 1–5, usually 2–3 per plate, cylindrical, thickened, blunt tip or tapered, 2–3 times as high as wide (4 times as high as wide when skin covering bases is removed), up to 0.4 mm high.

Adambulacral plates rectangular, sometimes constricted in middle, well separated from each other. Adambulacral spines longer than actinals, to 0.8 mm long, club-shaped, 4 times as high as wide; 3–4, per plate, positioned irregularly on plate, only sometimes in transverse row, usually only 1 on furrow margin; subequal or furrow spine larger. Furrow spinelets near jaw sometimes enlarged. No superambulacral plates, no internal extensions of abactinal or actinal plates; proximal interradial calcified pillar supports abactinal body wall. 3 oral spines on oral margin of plate, larger than adambulacral spines, 1–3 suboral spines. 2 series of suckered tube feet.

Reproduction. Separate sexes, egg size in gonad variable, to 0.8 mm dia, appears to breed throughout the year; possibly lays egg cases (Simpson, 1982).

Colour. Macquarie Island specimens (live) usually pale olive green on the dorsal surface (including superomarginals), sometimes light grey, purple or brown, arm tips paler; ventral surface (including inferomarginals) light tan, very light orange or cream; tube feet darker tan or orange; preserved material is tan with darker tube feet. Kerguelen specimens are light brown (Cherbonnier and Guille, 1975).

Habitat. In the immediate sublittoral (0.5–2 m) it is found on rock boulders or gutters underneath the kelp (*Durvillaea*) zone. In the sublittoral (to 20 m) found mostly on rocky substrates in association with sponges, hydroids and red algae, or amongst *Macrocystis* beds. McKnight (1984) has reported a dredged specimen from 95 m.

Distribution. Kerguelen (0–20 m), Macquarie Island (0–95 m).

Remarks. Examination of a range of specimens indicates that *Cycethra macquariensis* and *Asterina hamiltoni* are synonyms of *Asterina frigida*. Kochler (1920) did not compare his three species. Both Macquarie Island species were based on single specimens. The main differences in the descriptions are the relative size (smaller in *C. frigida*), density of the abactinal skeleton, the length of the abactinal spinelets and the number of actinal spinelets per plate (A.M. Clark, 1962). However, the minor variations in the numbers of actinal spinelets, abactinal spinelets and papulae, the density of the skeleton, and the colour do not form any recognisable pattern in the current range of specimens. Moreover, the skeleton is flexible and consequently preserved specimens can look superficially different depending on whether the arms are flexed slightly downward (dorsal skeleton appearing open, actinal spinelets spread out) or upward (dorsal skeleton appearing robust, actinal spinelets densely clustered). The thickness of skin around and on the spinelets can influence the shape and height/width ratio of the spinelets. Finally Cherbonnier and Guille (1975) have reported specimens from Kerguelen up to R = 22 mm, similar in size to material from Macquarie Island.

This species belongs in the Ganeriidae as defined by A.M. Clark (1983), having a rounded ventrolateral arm surface, small block-like marginals, lacking internal arm structures (fig. 2) and in lacking pedicellariae. A.M. Clark (1983) suggested that *Cycethra* should be monotypic given the extreme polymorphism of the type species *C. verrucosa* (Philippi, 1857). However, I can find no reliable character that would distinguish the two species at a generic level. On the other hand *C. frigida* is clearly distinguished from the related genera *Ganeria* and *Perknaster* by the presence in *C. frigida* of clusters of small spinelets on the abactinal, marginal and actinal plates. Specimens of *C. verrucosa* can vary from having abactinal plates with paxillae to low cresentic mounds (metapaxilliform) and marginal plates from small and inconspicuous to block-like and distinctive (A.M. Clark, 1983). *C. frigida* is similar to specimens of *C. verrucosa* with metapaxilliform abactinals and block-like marginals. *C. verrucosa* can be distinguished from *C. frigida* by the greater number (to 8) of adambulacral spinelets.

Goniasteridae

Ceramaster patagonicus Sladen

Plate 1d

Ceramaster patagonicus Sladen, 1889: 269, pl. 46 figs 3, 4, pl. 49 figs 3, 4.— Rowe and Gates, 1995: 65.—A.M. Clark, 1993: 249.— Branch et al., 1993: 44.

Ceramaster grenadensis patagonicus.—A.M. Clark and Downey, 1992: 236–237, figs 39e, f, pl. 55e–f.

Ceramaster lennoxkingi McKnight, 1973a: 178–180, fig. 4.—McKnight, 1984: 142. [new synonymy]

Material examined. Macquarie Island, ANARE 1986 Expedition, BT3, NMV F76237(1).

Description of Macquarie Island material. R = 75 mm, r = 58 mm. Body flat, pentagonal; interradial margins slightly concave; arm tips slightly upturned. Abactinal plates tabulate, large and hexagonal in centre of disc, smaller and quadrangular interradially; plates with approximately 12 marginal and 12–15 central granules (rarely to 24 marginal and 24 central spinelets), granules squat and polygonal. 2-jawed spatulate pedicellariae on some abactinal, marginal and actinal plates, larger than granules, usually widely open. Marginals conspicuous, 28 from arm tip to tip, covered in granules except in centre of superomarginals where 1–2 pedicellariae usually present. Actinal plates as abactinals, larger ones with 30 close-set granules. Adambulacral plates with 3–4 furrow spines and to 7 subambulacral spines in 2 longitudinal rows. Oral plates with 2 rows of 5–7 small angular spines along margin; 5 large and 5–8 smaller suboral spines. 2 rows of suckered tube feet.

Colour. Macquarie Island specimens (in alcohol) tan. Live Atlantic specimens are reddish orange above, cream below (A.M. Clark and Downey, 1992).

Habitat. Sand, mud (Sladen, 1889); rock (Branch et al., 1993).

Distribution. North Pacific, Bering Sea, Gulf of California, Burwood Bank Antarctica, Falkland Islands (106–192 m); Marion Island (527 m); Macquarie Island (105–148 m); the South Island and subantarctic islands of New Zealand (252–1125 m); southern Australia (no depth recorded).

Remarks. McKnight (1973a) distinguished his new species *C. lennoxkingi* from *C. patagonicus* by the more numerous abactinal spinelets and the fewer subambulacral spines. However, his specimens (R = 30–51 mm) were considerably smaller

than the holotype of *C. patagonicus* (R = 68 mm) and the distinction between the two nominal species appears to be size related. The present specimen conforms broadly to both descriptions. Branch et al. (1993) figured four large oral spines on a specimen from Marion Island, which is possibly a different species if this characteristic is constant.

Poraniidae

Porania antarctica Smith

Plate 1c

Porania antarctica Smith, 1876: 108.—Fisher, 1940: 154.—A.M. Clark, 1962: 34.—Branch et al., 1993: 46. —A.M. Clark, 1993: 232.

Porania glaber Sladen, 1889: 360-362, pl. 59 figs 1, 2.

Porania antarctica antarctica.—McKnight: 1984: 142.

Material examined. Macquarie Island, AM 1977–1978 Expedition, Caroline Cove (13–18.3 m), MA-303(1), MA-311(1); ANARE 1986 Expedition, BT2, NMV F60278(1); BT4, NMV F76226(1). Heard Island, Camp Beach 16 Aug 1951, washed up after storm, NMV(6); SW Beach, Aug 1951, NMV F75926(1).

Description of Macquarie Island material. R to 59 mm, r to 25 mm, height to 25 mm. 5 arms, broadly triangular. Disc high, madreporite small at top of interradial margin. Disc and arms covered in thick skin obscuring underlying skeleton. Dorsal spines thick, tapered to blunt tip, up to 2.2 mm high, twice as high as wide, smaller distally. Spine distribution on arms variable, NMV F60278, R = 25 m, with 1 carinal and 1 lateral longitudinal row of 6 spines; R = 50 mm (MA-303), with carinal row of 15 spines and 2 lateral rows of 10 spines; R = 59 mm (MA-311), with sinuous carinal row of 30 spinelets and 4–8 lateral spinelets not organised into longitudinal rows. Some spines scattered on disc, occasionally 2 close together. Clusters of 1–10 papulae scattered amongst dorsal spines. Marginal spines slightly thinner than dorsal spines, slightly flattened, sometimes truncate, 1, sometimes 2, spines per plate, to 2.2 mm long. Ventral disc skin with notable radial striations (fascioles), no papulae, no spines. 2, distally 3, furrow spines, outer spine largest, flattened and truncate, inner spines smaller, subcylindrical, each orientated obliquely to furrow. 2 oral spines at jaw apex, 2–3 small, pointed spines along furrow edge, 0–1 suboral spines. 2 series of tube feet. No pedicellariae.

Reproduction. Macquarie Island specimens with gonads attached to the interradial septa, genital pore situated abactinally; gonad consisting of a dense bunch of branching tubules, to 12 mm long, containing abundant eggs, eggs to 0.5 mm dia. Specimens of *P. antarctica* from McMurdo Sound, Antarctica, have numerous eggs (30,000–40,000), average size 0.55 mm dia, which develop into pelagic feeding larvae (Bosch, 1989).

Colour. Macquarie Island specimens (preserved) are off-white with brown tube feet. Branch et al. (1993) reported their Marion Island specimens as being a pink colour. Fisher (1940) recorded one live Falkland Island specimen as scarlet.

Habitat. The two Australian Museum specimens were collected amongst *Codium* or red algae adjacent to dense *Macrocystis* beds growing on boulders. Branch et al. (1993) recorded Marion Island specimens from rock, sand and sand with > 5% mud. Sladen (1889) recorded a juvenile specimen from the abyssal plain near the Crozet Islands (2976 m).

Distribution. Antarctica (12–1335 m), Magellanic region, South America north to 35°S (18–320 m), Prince Edward Islands (10–280 m), Crozet (2976 m), Kerguelen (shore–23 m), Heard Islands (shore–150 m); Macquarie Island (13–105 m).

Remarks. The present specimens have strongly developed dorsal and marginal spines similar to those found on specimens from Marion Island (A.M. Clark, 1962) and Kerguelen (Guille, 1974). Several subspecies have been proposed by Fisher (1940) and A.M. Clark (1962), however, they are not clearly distinguished either morphologically or geographically. There is an undescribed species recorded from McMurdo Sound in the Ross Sea (A.M. Clark, 1962; H.E.S Clark, 1963; Bosch, 1989). This species is distinguished by the smaller body size (R to 30 mm), genital pores located on the oral surface, the relatively few eggs (100–310), and the development of lecithotrophic demersal larvae. Other small paucispinous specimens from eastern Antarctica may prove to be a third species (A.M. Clark, 1962). The trinomial *P. antarctica glabra* Sladen, 1889 has been used for these animals (e.g., H.E.S. Clark, 1963; McKnight, 1976; Mein, 1992) but this is inappropriate as the type of *P. glabra* is from Kerguelen where it falls within the range of variation shown by specimens of *P. antarctica* (A.M. Clark, 1962).

Order Velatida

Solasteridae

Solaster notophrynus Downey

Plate 1g–h

Solaster notophrynus Downey, 1971: 39–42, fig. 1.—A.M. Clark and Downey, 1992: 305, pl. 73e–f. – A.M. Clark, 1996: 193.

Solaster dianae Stampanato and Jangoux in Branch et al., 1993: 45 [in key with figures] [new synonymy].

Solaster dianei.—Stampanato and Jangoux, 1993: 183.

Material examined. Macquarie Island, ANARE 1986 Expedition, BT8, NMV F60290(1); Australia, off Northwest Tasmania, 41°06′S, 143°50′E, 1110–1300 m, NMV F82065(1).

Comparative material examined. Solaster subarcuatus Sladen, 1889: Antarctica, Enderby Land, 65°48′S, 53°16′E, 209–180 m, 24 Jan 1930, BANZARE stn 41, SAM K1453(6); Australia, off Port MacDonnell, 800–1000 m, AM J17796(1).

Description of Macquarie Island material. R = 40 mm, r = 11 mm. 7 arms, widened at base, tapering rapidly after half R to blunt, round tip; madreporite indistinct, slight interradial sulcus. Abactinal plates in close regular reticulum, usually quadrilobed, imbricating with neighbouring plates. Paxillae small with low widened pedicel, to 0.6 mm high, bearing 5–15, low cylindrical blunt, thorny, spinelets, to 0.15 mm long. Abactinal paxillae 0.4–0.6 mm diameter, larger in interradial disc sulcus, to 0.8 mm diameter, smaller adjacent to marginals. Papular areas small with usually 1 papula, papulae present on disk and arms. Paxillae on disc and lateral arm surfaces in regular oblique rows, plates on dorsal arm surfaces less regularly arranged, sometimes trilobed with 2 papulae between plates.

Superomarginals similar to abactinals, slightly larger than abactinals on smaller specimen, much smaller than inferomarginals; paxillae with up to 12 spinelets. Proximal plates alternate in position with inferomarginals, other plates aligned transversely. Inferomarginals large, 31 plates along arm, separated by less than their height. Paxillae with high, laterally compressed pedicels, up to 30 short conical, terminally thorny, spinelets (mostly broken) in 3–4 transverse rows. 5 series of actinals on ventral disc area, only 1 series persists after 14th marginal (two-thirds R), paxillae small, with 5–8 spinelets. No actinal papulae.

Adambulacrals narrow, widely separated, 43 along arm; with 3–5 long tapered webbed furrow spines in finger-like spread, to 1.5 mm long; 6–14 long thin subambulacral spines, largest near furrow, to 1.1 mm, subequal with furrow spines, not webbed, some thickened at tip. First adambulacral plate on smaller specimen with 5 furrow spines and 14 subambulacral spines in 3 transverse rows. Next few plates with 4 furrow spines and 1–2 rows of subambulacrals. Plates at half R with 3 furrow and 8 subambulacral spines in a single transverse row. Distal plates with 3 furrow and 6 subambulacral spines.

Oral plates widened and tumid; 10 furrow spines, webbed at their base, innermost 2–3 enlarged and pointed, to 2.0 mm, lateral spines interleave with spines on opposing jaw, up to 25 suboral spines on raised section of plate, inner few enlarged, terminally thorny, rest small, conical. Oral suture wide and bare. 2 series of tube feet.

Reproduction. Macquarie Island specimen female; gonads small, shaped like bunch of grapes, attached to dorsal end of interradial arc; numerous eggs, 0.2 mm dia.

Colour. Macquarie Island specimens (in alcohol) white. Atlantic specimens dark-reddish brown (Downey, 1971).

Habitat. Marion specimens recorded from rock (Branch et al., 1993)

Distribution. Northwestern Atlantic (660–1230 m), Prince Edward and Marion Islands (335–475 m), Macquarie Island (330–450 m), Australia (1100–1300 m).

Remarks. Solaster notophrynus is characterised by the numerous suboral and subambulacral spines (pl. 1h), the small dense abactinal paxillae arranged in regular transverse and oblique series, and the shape and number of the arms (pl. 1g). The specimen from Australia is larger (R=70 mm) than the Macquarie specimen but differs only in having slightly fewer subambulacral spines. A similar species *Solaster dianae*, has been recently recorded from Marion and Prince Edward Islands (Branch et al., 1993). A full description of this species has not been published, however one of the authors (S. Stampanato) has kindly supplied me with a description and photos of the holotype. *S. dianae* is very similar in general appearance to *S. notophrynus*, the only apparent difference being that the superomarginal plates are distinct in *S. dianae* but indistinguishable from the abactinal plates on the holotype of *S. notophrynus*. This

feature is variable on the arms of the two specimens I have examined and there appears to be no reason to retain *S. dianae* as a separate species.

Solaster is predominantly a northern hemisphere genus. The other exceptions are *S. torulatus* Sladen, 1889, known from off New Zealand and the Kermadec Islands in 1042–1116 m; *S. longoi* Stampanato and Jangoux, 1993 from the Enderby quarter of Antarctica; *S. subarcuatus* Sladen, 1889 from Kerguelen and southern Australia; and *S. regularis* Sladen, 1889 from throughout the Southern Ocean (although not yet from Macquarie Island). These species have fewer spines and spinelets, and with the exception of *S. torulatus* larger paxillae and more arms (8–10). *Solaster* differs from the closely related *Crossaster* by the smaller, denser abactinal paxillae, arranged into oblique rows.

Crossaster multispinus H.L. Clark

Plate 1f

Crossaster multispinus H.L. Clark, 1916: 66, pl. 18 figs 5, 6.—H.L. Clark, 1946: 150.—Rowe and Gates, 1995: 113.

Material examined. Macquarie Island, ANARE 1986 Expedition, BT8, NMV F60291(1).

Australia, Tasmania, Bruny Island, 270–314 m, AM E5078(2 syntypes); Eastern Bass Strait, 39°11.3′S, 148°41.2′E, 440–464 m, 6 Feb 1985, NMV F82985(1); 39°3.3′S, 148°38.0′E, 435–480 m, 6 Feb 1985, NMV F82986(1).

Description of Macquarie Island material. R = 23 mm, r = 12 mm. 10 short arms, tapered evenly to blunt tip. Abactinal plates in irregular open reticulum, paxillate with thick pedicel and bristling crown of 15 long sharp spinelets (mostly broken), with 3–4 narrow connecting bars to neighbouring plates. Large papular areas with 1–2 papulae, smaller paxillae developing within papular areas with 1–4 spinelets. Superomarginals similar to abactinals; inferomarginals large, 14 along arm, laterally compressed, widely spaced, separated in middle of arm by more than their height, pedicel large, thick, bearing to 30 long, serrated, spinelets (to 1.3 mm long) in 3–4 transverse rows; some smaller paxillae interspersed. Actinal disc area with up to 3 rows of small sparse paxillae, not extending onto arm. Adambulacrals with 5–6 long slender tapered, slightly serrated furrow spines (mostly broken), webbed to third of their height, to 7 subambulacral spines in transverse row or arc, to 1.45 mm long, decreasing in height away from furrow, slightly larger than furrow spines, flattened, webbed but not joined by web to furrow spines. Oral plates widened with up to 11 webbed furrow spines, innermost 4 enlarged, up to 10 suboral spines on raised section of plate, increasing in size towards apex.

Colour. Macquarie Island specimen (in alcohol) white, tube feet brown. Live colour of an Australian specimen (NMV F82985) dull yellow-olive dorsally with paler arm tips.

Habitat. Unknown.

Distribution. South eastern Australia, New Zealand (90–1152 m); Macquarie Island (330–450 m).

Remarks. This specimen is the first record of *Crossaster* from Macquarie Island. It closely matches the description of H.L. Clark (1916). It was compared with syntypes of *C. multispinus* and several other specimens from southern Australia in Museum Victoria. The only slight differences are in the length of the inferomarginal spinelets and the number of arms, which is almost always 11 on Australian specimens.

H.B. Fell (1958) synonymised *C. multispinus* with *C. japonicus* (Fisher, 1911) from Japan after examining several specimens from New Zealand. Rowe and Gates (1995) have disagreed and retained the name *C. multispinus* for Australian specimens. The identity of the New Zealand specimens is unclear, but judging from the descriptions and figures of H.B. Fell (1958) and H.E.S. Clark (1970), they appear conspecific with the Australian and Macquarie Island species. A similar species, *C. penicillatus* (Sladen, 1889), is known from off South Africa, Marion Island, Tristan da Cunha, and Gough Island from 55–800 m (A.M. Clark and Downey, 1992). It differs in having slightly fewer spinelets, 10 on abactinal plates, 15 on inferomarginals, 4–5 furrow spines, and has 8–11 (usually 10) arms. *C. campbellicus* McKnight, 1973d from off New Zealand has 10 arms but differs in having fewer spinelets, only 2–5 on abactinal plates.

Pterasteridae

Pteraster affinis Smith

Pteraster affinis Smith, 1876: 108.—Koehler, 1917: 48, pl. X fig. 11.—A.M. Clark and Downey, 1992: 326.—A.M. Clark, 1996: 206.

Pteraster affinis affinis.—A.M. Clark, 1962: 63, text-figs 10f, g.

? *Hymenaster* sp. (juv).—A.M. Clark, 1962: 67.

Material examined. Macquarie Island, AM 1977–1978 Expedition, Caroline Cove (8 m), MA-300 AM J22731(1); Kerguelen, Royal Sound, 2–20 m, 10 Feb 1930, BANZARE stn 49, SAM K1461(1); Bras

Bolinder, 20–30 m, 14 Feb 1930 BANZARE stn 53, SAM K1462(2); Heard Island, Camp Beach 16 Aug 1951, washed up after storm, NMV F76183(1).

Comparative material examined. Hymenaster sp.: Macquarie Island, Off Lusitania Bay, 54°42.58′S, 158°54.5′E, 69 m, 5 Dec 1930, BANZARE stn 83, SAM K1469(1).

Description of Macquarie Island material. R = 13 mm, r = 7 mm; 5 arms, short, triangular, blunt tip; interradial arcs rounded. Abactinal plates paxillate; 2–6, usually 4, subequal paxillar spinelets, thin, slightly flattened, to 1.0 mm long, slightly serrated or widened at tip, fenestrated surface. Paxillar pedicel small, twice as high as wide. Thick, pulpy supradorsal membrane connecting spinelets at midheight. Actinolateral fringe of spines connected by continuous webbing along arm, spines flat, striated, truncate tip, to 2.0 mm long. 4 webbed adambulacral spines in transverse row near furrow. 5 webbed marginal spines on each oral plate, webbing not continuous over jaw apex; 1 large suboral spine, distally directed, largely covered in membrane, tricarinate near pointed tip. 2 rows of suckered tube feet.

Reproduction. Macquarie Island specimen female, gonad mass small (2 mm wide) consisting of a bunch of short transparent tubules with 2–3 eggs; approximately 30 eggs per gonad; eggs elongate, to 0.4 mm long. Gonad is attached near the dorsal margin of the arm, near to the interradial arc.

Colour. (In alcohol) tan.

Habitat. The Macquarie Island specimen was found on boulders in a dense *Macrocystis* bed at 8 m. Branch et al. (1993) recorded their Marion Island specimens from rock, sand and gravel.

Distribution. Antarctica (0–603 m), Magellanic region (0–740 m), Kerguelen (0–91 m), Heard Island (shore), Macquarie Island (8 m), Marion Island.

Remarks. The condition of the specimen is poor; many spines are broken and the animal is quite flaccid. Nevertheless, enough diagnostic characters are visible to fully identify the specimen, including the large erect suboral spine, and the number and webbing of spinelets. A.M. Clark (1962) recognised three subspecies of *P. affinis* that surround the Southern Ocean: *P. affinis lebruni* Perrier, 1891 reported from Argentina, the Falkland/Magellan region and the Prince Edward Islands; *P. affinis aculeatus* Koehler, 1920 occurring in eastern Antarctica from Kemp Land and the Ross Sea; and *P. affinis affinis* from Kerguelen. However, A.M. Clark and Downey (1992) point out the overlap between these supposed subspecies and the close relationship of *P. affinis* with *P. militaris* from the Arctic. The Kerguelen specimens that I have examined are very similar to those from Macquarie and Heard Islands, differing only in having thicker opaque webbing between the spinelets, but this may be due to differences in preservation.

McKnight (1984) recorded a small specimen (R = 17 mm) of *P. stellifer stellifer* Sladen, 1882 from Macquarie Island. Sladen (1889) described this species as having five marginal oral spines not connected by webbing, a smaller proximally directed suboral spine, and regular "stellate" abactinal paxillae with six subequal spinelets. I have not been able to examine McKnight's specimen but it appears from the description to differ from the type in having up to 7–9 spinelets on the abactinal paxillae, the peripheral spinelets (0.75 mm long) truncate, tapering slightly and the central spinelet long (1.5 mm) stout and non-tapering. More specimens are required to clarify the relationship. A.M. Clark (1962) recognised two subspecies of *P. stellifer*, *P. stellifer hunteri* Koehler, 1920 differing from *P. stellifer stellifer* in having flared paxillar spinelets. However, subsequently A.M. Clark and Downey (1992) list *P. hunteri* as a synonym of *P. stellifer* without comment. *P. stellifer* has been recorded from southern South America and around Antarctica (79–2084 m), including the Balleny Islands (McKnight, 1976 as *P. stellifer hunteri*)

A.M. Clark (1962) has also recorded a tiny specimen (R = 3.5 mm) of a undetermined *Hymenaster* species from Macquarie Island which I have examined. The oral and adambulacral spines lack webbing as is characteristic of *Hymenaster*. The specimen has approximately 20 abactinal paxillae with 5–8 spinelets, the middle 1–3 longest, 2–3 subambulacral spines, two oral and one small suboral spine. The specimen is obviously a juvenile, possibly even a juvenile of one of the *Pteraster* species listed above, and its true affinities cannot yet be determined.

Order Spinulosida

Echinasteridae

Henricia obesa (Sladen)

Plate 2a

Cribella obesa Sladen, 1889: 544–45, pl. XCVI figs 3, 4, pl. XCVIII figs 5, 6.

Henricia obesa.—Fisher, 1940: 164.—A.M. Clark, 1962: 48, figs 5n, 6a–c.—McKnight, 1984: 143.—Rowe and Albertson, 1987: 190–192, figs 2a, b.—A.M. Clark and Downey, 1992: 392–393, fig. 60s, pl. 95a.—A.M. Clark, 1996: 237.

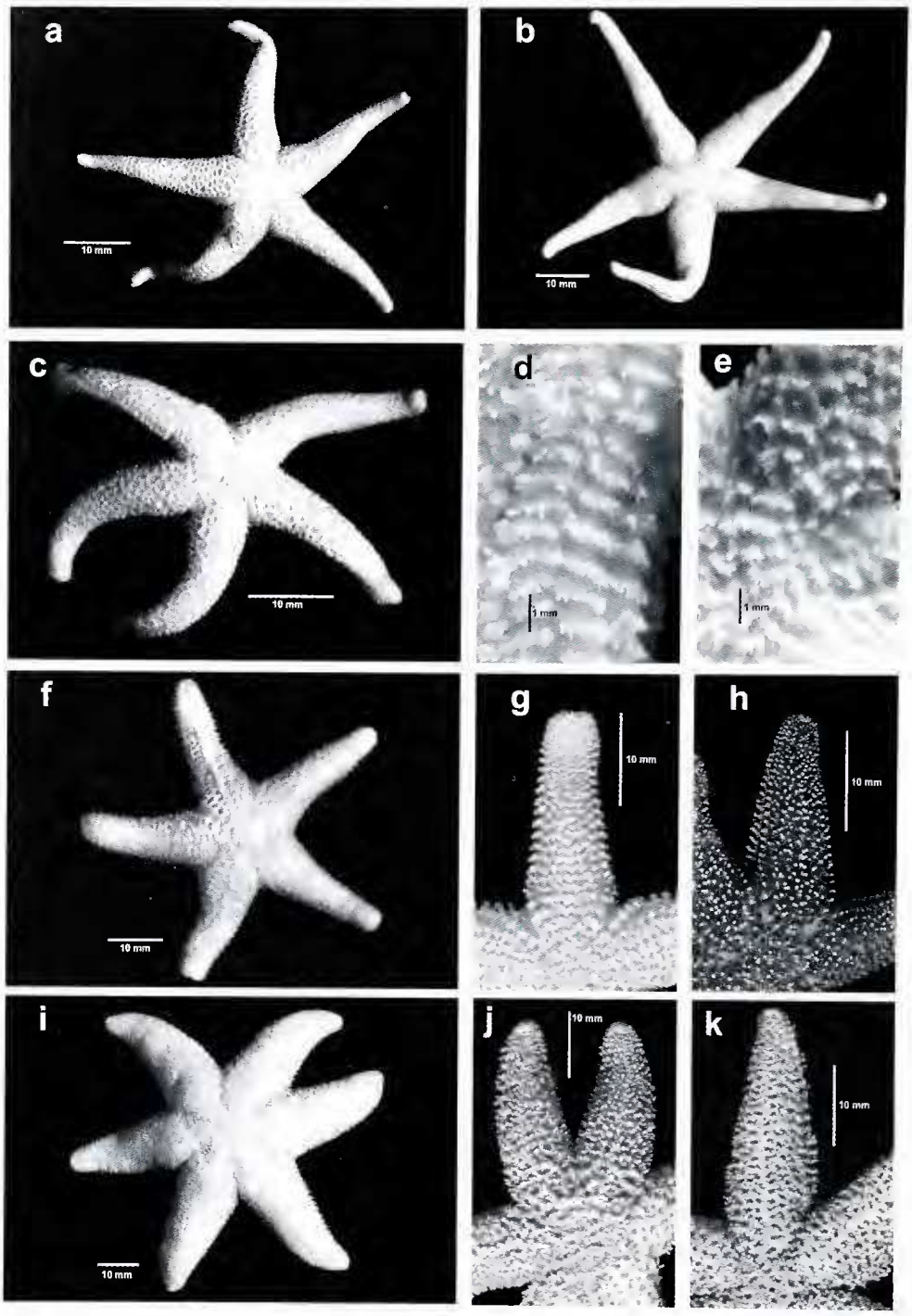

Plate 2. a, *Henricia obesa*, dorsal view, NMV F60281; b, *Henricia studeri*, dorsal view, NMV F60287; c, *Odontohenricia anarea*, paratype, dorsal view, NMV F60289; d, *Odontohenricia anarea*, adambulacral and marginal spinelets, NMV F60289; e, *Odontohenricia anarea*, abactinal spinelets, NMV F60289; f, *Anasterias directus*, dorsal view, NMV F77766; g, *Anasterias directus*, dorsal view of arm (skin removed on upper arm), NMV F76241; h, *Anasterias directus* "*antarctica* form", dorsal view of arm, NMV F76242; i, *Anasterias mawsoni*, dorsal view, NMV F76170; j, *Anasterias mawsoni*, dorsal view of arm, NMV F76164; k, *Anasterias mawsoni* "*sphoerulatus* form", dorsal view of arm, NMV F76181.

Henricia lukinsi.— McKnight, 1984: 143 [non *H. lukinsi* (Farquhar, 1898)].

Henricia sp. aff. *obesa*.—O'Hara, 1998a: 146.

Material examined. Macquarie Island, AM 1977–1978 Expedition, Caroline Cove (8–18 m), MA-298 AM J22732(1), MA-300 AM J22730(1), MA-303 AM J22733(1), MA-306(1). ANARE 1986 Expedition, BT2, NMV F60281(13); BT3, NMV F60280(3); BT4 NMV F76223(7); BT5, NMV F60282(1); BT10, NMV F60279(2); off Lusitania Bay, 54°42.5′S, 158°54.5′E, 69 m, 5 Dec 1930, BANZARE stn 83, SAM K1449(4) and BMNH, 1965.8.5.108–110(4); 54°23.9′S, 158°59.3′E, 183 m, NZOI stn A698, identified by McKnight (1984) as *H. lukinsi*, NIWA(1).

Falkland Islands, Port William, 51°40′S, 57°50′W, 22 m, 26 Jan 1876, sand/gravel, *Challenger* stn 315, BMNH 90.5.7.831–3 (holotype and paratypes of *H. obesa*); *Discovery* stns WS 81,84, 85, 86, 93, 220, 75–151 m, identified by Fisher (1940), BMNH, 1948.3.16.467 –470(4).

Australia, New South Wales, Shoalhaven Bight, 512 m, identified by Rowe and Albertson (1987), AM J13288(7); Victoria, East of Gabo Island, 410–450 m, identified by Rowe and Albertson (1987), AM J18628(3).

Comparative material examined. *H. aucklandiae* Mortensen, 1925: Auckland Island, Carnley Harbour, 29 Nov 1914, ZMUC(syntype); Figure Eight Island, 2 Dec 1914, ZMUC(syntype); Masked Island, 3 Dec 1914, ZMUC(syntype); Chatham Islands, low tide, identified by H.B. Fell (1960), BMNH, 1952.4.16.17(2). *H. lukinsi* (Farquhar, 1898): Auckland Island, Carnley Harbour, Figure Eight Island, 2 Dec 1914, identified by Mortensen (1925), ZMUC(1); Auckland Island, Laurie Harbour, *Discovery* Expedition, 1904, identified by A.M. Clark (1962), BMNH 1905.7.14.10(1); Campbell Island, off East Cape, 18 m, 13 Jan 1980, AM J22905(1).

Description of Macquarie Island material. R = 9–46 mm, r to 10 mm; 5 equal subcylindrical or flattened arms (1 specimen with 6 arms NMV F60281), sometimes inflated at base, slender distally, tapering to round tip, tip often curled. Abactinal plates in coarse reticulum, papular areas largest on base of arm, to 1.5 mm dia., with 3–9 papulae, secondary plates sometimes present in papular areas, few papulae on disc. Abactinal plates with irregular row of 1–6 short stout, tapered or slightly capitate, terminally thorny spinelets, l/w = 1.5–2 (3 when skin is removed), to 0.4 mm high. Superomarginals quadrilobed or rhomboidal with up to 6 spinelets clustered on dorso-distal side of plate. Inferomarginals quadrilobed, imbricating, 6–8 spinelets in irregular transverse row. Usually 1 series (sometimes 2–3 series on specimens R > 40 mm) of bar-like intermarginals extending to quarter R with 2–4 spinelets in transverse row. Actinals square-shaped, extending to two-thirds R, with 2–4 spinelets, 3–10 bar-like plates in second series proximally, to half R on largest specimens. Marginal and some actinal papulae present. 10 adambulacrals to 7 inferomarginals, 1 slender spine in furrow, 1–2 large club-shaped spines on furrow edge, 3–5 subambulacral spines in 1 (smaller specimens) or 2 (larger specimens) rows. Oral plates each with 3–5 furrow spines, innermost enlarged, 1–3 suboral spines. Some actinal papulae.

Reproduction. AM Expedition specimens with gonads consisting of several tubules with 2–3 rows of short lateral branches or lumps, attenuating is size distally; sexes separate, female gonads with eggs of varying size classes, 0.1–1.2 mm dia, large eggs relatively few in number.

Colour. Macquarie Island specimens (in alcohol) dark brown, tan or off-white, with yellow-brown adambulacral area, brown tube feet. Fisher (1940) recorded the live colour of Falkland Islands specimens as orange-yellow, paler distally.

Habitat. The four AM Expedition specimens from Caroline Cove were found amongst a dense *Macrocystis* bed (8–18 m). McKnight's (1984) record of a Macquarie Island specimen from "0 m" at Sandy Bay was presumably a beach-washed specimen. Falkland Islands specimens were recorded from coarse sand, fine sand, stones, gravel, shell (Fisher, 1940). A Marion Island specimen has been collected from rock (Branch et al., 1993)

Distribution. South America, Falkland Islands (22–450 m); Marion Island (527 m); Macquarie Island (8–433 m); southeastern Australia (73–604 m).

Remarks. I have followed A.M. Clark (1962) and McKnight (1984) in referring these specimens to *H. obesa*. This species is characterised by an open skeleton, robust abactinal spinelets arranged in 1–2 rows along the plates, and adambulacral spinelets also arranged in 1–2 transverse rows. However, there are some slight differences that distinguish the Macquarie Island material from specimens from South America and Australia. These latter specimens (including the types) have consistently smaller (0.2–0.3 mm) and more numerous abactinal spinelets. Up to 15 spinelets occur in 2 (or even 3) rows along the abactinal plate. Larger animals have a more open skeleton with more secondary calcification than Macquarie specimens of the same size. Many authors, including Fisher (1940) and Hayashi (1941), have commented on the extreme difficulty in

identifying *Henricia* material and I refrain from establishing a new species on the basis of such small differences.

McKnight (1984) has recorded two additional *Henricia* species from Macquarie Island that are otherwise known from the subantarctic islands of New Zealand: *H. aucklandiae* Mortensen, 1925 and *H. lukinsi* (Farquhar, 1898). I have examined a specimen identified by McKnight as *H. lukinsi* and one as *H. aucklandiae*. The *H. lukinsi* specimen is identical to my *H. obesa* material. The specimen of *H. aucklandiae* has numerous spinelets and is referable to *H. studeri* (see below).

H. lukinsi material from New Zealand can be distinguished from *H. obesa*. *H. lukinsi* is a small species (R to 24 mm) with adambulacral, actinal and marginal spinelets aligned in a prominent row on each transverse series of plates. Other notable features include the denticulate nature of the abactinal spinelets, and a shallow depression in each interradial disc area. On the other hand New Zealand specimens of *H. aucklandiae* are very similar to *H. obesa* differing only in having a slightly more compact skeleton and *H. aucklandiae* appears to be no more than a regional variant of *H. obesa*. Large specimens of *H. aucklandiae* (R=37 mm) have 7–9 adambulacral spinelets (0.25 mm high) in two rows, 15–18 abactinal spinelets in clusters or in two rows, a single row of actinal plates extending almost to the ray tip and some intermarginal plates at the base of the arm. Molecular or developmental studies are required to determine whether the difference between all these regional forms are of specific or infraspecific rank.

Henricia studeri Perrier

Plate 2b, Figure 3a–c

Henricia studeri Perrier, 1891: 102–103, pl. 9 fig. 2.—Fisher, 1940: 163–164, pl. 11 fig. 1.—A.M. Clark and Downey, 1992: 398, fig. 60n.—A.M. Clark, 1996: 242.

Henricia aucklandiae.—McKnight, 1984: 143 [non *H. aucklandiae* Mortensen, 1925].

Material examined. Macquarie Island, ANARE 1986 Expedition stn BT2, NMV F60286(2); NMV F60287(1); BT3, NMV F60285(1); BT4 NMV F76224(1); BT8, NMV F60287(1); BT10, NMV F60283(1); off Buckles Bay, 372 m, Feb 1967, NMV F60284(1); 54°59.7′S, 158°36.4′E, 155–198 m, NZOI stn E236a, identified by McKnight (1984) as *H. aucklandiae*, NIWA(1).

Falkland Islands, *Discovery* stns WS 81, 85, 86, 872, 147–151 m, identified by Fisher (1940), BMNH 1948.3.16.453–465(12).

Comparative specimens examined. H. compacta (Sladen, 1889): West of New Zealand, 38°50′S, 169°20′E, 510 m, 23 Jun 1874, *Challenger* stn 166, BMNH 90.5.7.830(holotype); Australia, off Tasmania, 42°43′S, 148°25′E, 506 m, 25 Jun 1984, NMV F76238(1). *H. abyssalis* (Perrier, 1894): South Africa, off Cape of Good Hope, 304 m, BMNH, 1903.8.1.80(2).

Description of Macquarie Island material. R = 18–38 mm, r to 7 mm, arms 5, elongate, slender, tapered, cylindrical, slightly inflated at base, usually curled at tip. Disc small; anus central, noticeable; madreporite small, at interradial margin. Abactinal plates in irregular compact reticulum, papular areas not large, to 0.45 mm dia., with 2–3 papulae, little secondary calcification, no accessory plates. Plates quadrilobed or trilobed, imbricating with 2–4 neighbouring plates, with small crescentic central raised section, 3–30 clustered spinelets per plate, to 5 wide, spinelets l/w = 4–6, with 2–4 minute thorns at the tip, to 0.2 mm high. Marginals clearly visible in regular longitudinal rows. Superomarginals quadrilobed or irregular, imbricating, with thickened distal edge, up to 30 spinelets, similar to abactinal spinelets. Inferomarginals larger, quadrilobed or rhombic, with thickened proximal edge, up to 40 spinelets (to 0.14 mm long), few intermarginal plates present at greatest arm breadth (fifth R), similar to superomarginals. 1 series of actinals extend the arm length, closely imbricating, distal edge thickened, 10–20 spinelets, in clusters or in 3 transverse rows on proximal plates. 1 adambulacral plate to every inferomarginal. 1, sometimes 2, small spines in furrow; 2, sometimes 3, large stout capitate spines at furrow edge (to 0.55 mm long), with 7–10 subambulacral spines, in 2–3 transverse rows, spine height decreasing away from furrow, some thorny. Marginal and actinal papulae present even at arm base. Oral plates each with 3–4 furrow spines, innermost enlarged (0.6 mm long), 2 suboral spines.

Colour. Macquarie Island material (in alcohol) off-white. A.M. Clark and Downey (1992) recorded live colour of Atlantic specimens as orange-yellow to light red above, dull yellow below. Marion Island specimens are pale (Branch et al., 1993).

Habitat. Coarse sand, shell, stones (A.M. Clark and Downey, 1992); rock (Branch et al., 1993).

Distribution. South America, Falkland Islands (74–430 m), Prince Edward Islands (474–527 m), Macquarie Island (100–450 m), Marion Island.

Remarks. Henricia studeri is related to several other *Henricia* species that circle the Southern

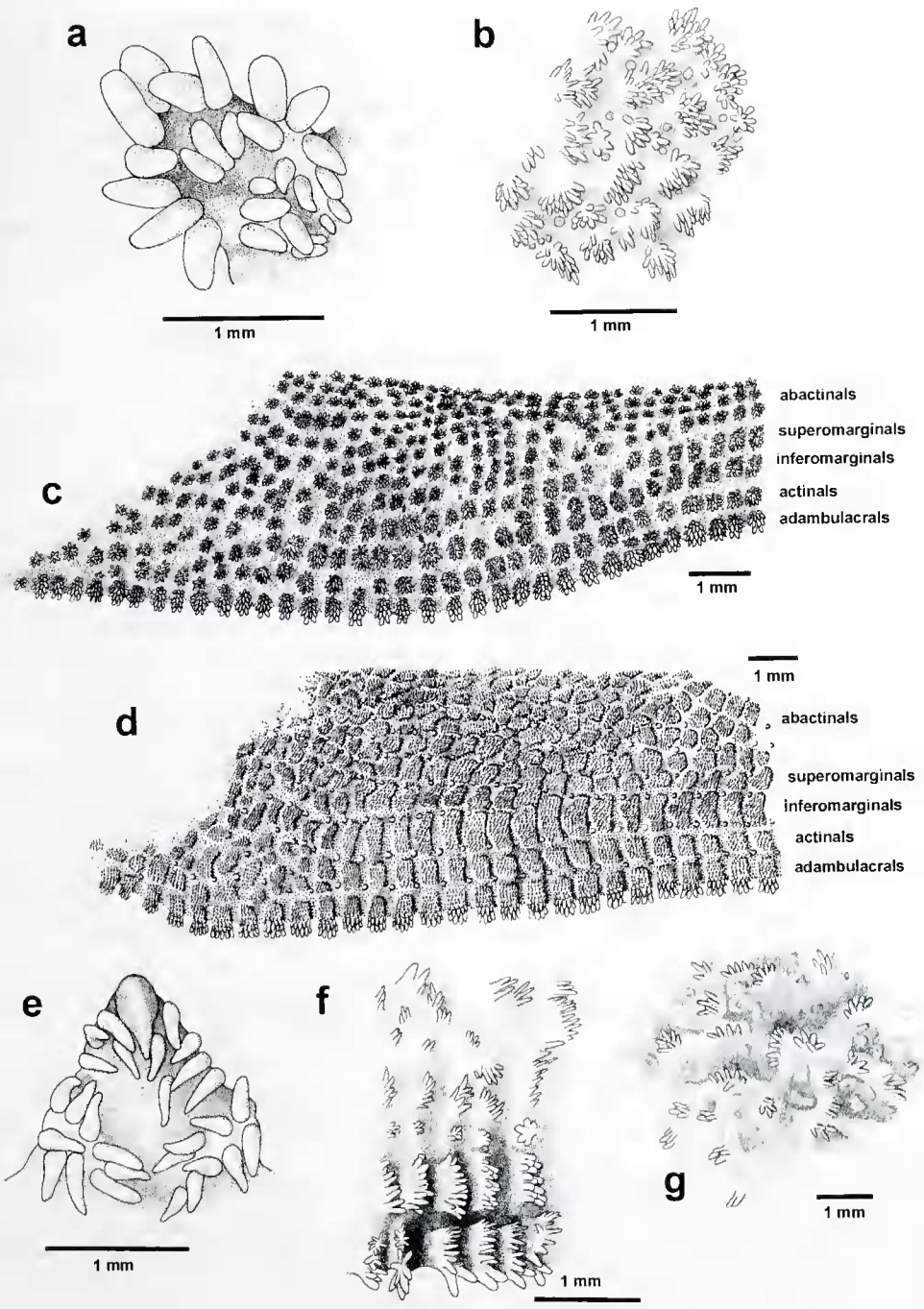

Figure 3 a–c, *Henricia studeri*, NMV F60287: a, detail of a jaw showing the position of the oral spinelets; b, detail of dorsal arm surface showing arrangement of abaetinal spinelets; e, ventrolateral view of the base of an arm, showing the arrangement of marginal plates. d, *Henricia compacta*, NMV F72238: ventrolateral view of the base of an arm, showing the arrangement of marginal plates. e–g, *Odontohenricia anarea*, holotype, NMV F60288: e, detail of a jaw showing the position of the oral spinelets; f, ventrolateral view of a section of an arm; g, detail of dorsal arm surface showing arrangement of abaetinal spinelets.

Hemisphere including *H. compacta* (Sladen, 1889), *H. abyssalis* (Perrier, 1894) and *H. praestens* (Sladen, 1889). These species were characterised by A.M. Clark (1962) as having a large numbers of spinelets, two furrow spines and a extensive row of actinal plates, usually extending to the arm tip. The Macquarie Island specimens conform to the descriptions given by Perrier (1891) and A.M. Clark and Downey (1992) for *H. studeri*. They are identical to Falkland Islands material identified by Fisher (1940).

The Macquarie Island material was compared to the juvenile holotype of *H. compacta* and to larger specimens from off southeastern Australia. *H. compacta* differs from *H. studeri* in having a more compact abactinal skeleton, smaller, finer abactinal spinelets, and more subambulacral spines. The marginal plates on *H. compacta* are quite pronounced and often irregularly placed, particularly at the base of the arms (fig 3d), there being fewer superomarginal than inferomarginal plates. *H. praestens*, known from off Marion and Crozet Islands, has a secondary skeletal network, fewer dorsolateral spinelets, knob-shaped furrow spines and is an orange colour (Branch et al., 1993). *H. abyssalis* which has been found in deep water off South Africa is a much larger species with two series of actinal plates that continue to the arm tip.

Odontohenricia anarea sp. nov.

Plate 2e–e, Figure 3e–g

Odontohenricia sp. nov.– O'Hara, 1998a: 146.

Material examined. Holotype, off Judge and Clerk Rocks, 54°23.6'S, 158°59.3'E, 100 m, 10 Dec 1986, stn BT10, NMV F60288.

Paratypes, type locality and date, NMV F60289(2).

Other material. Macquarie Island, off Lusitania Bay, 54°42.5'S, 158°54.5'E, 69 m, 5 Dec 1930, BANZARE stn 83, SAM K1826(1).

Comparative material examined. O. clarkae Rowe and Albertson, 1988: South Africa, 34°33'S, 18°20'E, 290 m, BMNH 1987.4.9.1.1(holotype). *O. endeavouri* Rowe and Albertson, 1988: eastern Bass Strait, 38°9.1'S, 149°54.0'E, 440 m, NMV F82983(1).

Description. Holotype. R = 26 mm, r = 5 mm, br = 6 mm. Arms 5, cylindrical, slightly broadened at base, tapering gradually to rounded tip. Disc small, madreporite near interradial margin, anus central. Abactinal plates in reticulum, plates crescentic or bar-like, imbricating with 2–3 neighbouring plates, which surround sunken, round, oval or irregular papular areas, papular areas 0.7–1.3 mm dia. Raised ridge on plate bearing combs of 2–8 spinelets (typically 3–5), in 1, occasionally 2, rows. Spinelets small, slender, slightly capitate or tapered, minutely thorny (when skin removed), 0.3–0.5 mm high and 0.1 mm wide. Papular areas with 1–4 papulae around rim, often with an accessory plate in centre. Marginals distinct in regular transverse and longitudinal rows, to 40 along arm. Superomarginals quadrilobed, often irregular in shape, longer than wide, raised section on plate triangular or bar-like, with up to 10 spinelets in 2 transverse rows. Intermarginals bar-like, single row extending up to 14 plates along arm (half R), up to 4 spinelets clustered on proximal plates. Inferomarginals larger, quadrilobed or rhomboidal, with up to 16 spinelets in several rows, to 0.4 mm high. Actinals square or rectangular, extend to half R, with up to 7 spinelets in 1–2 rows. Marginal and actinal papulae present, usually 1 per area. Adambulacrals rectangular, 9 adambulacrals to every 7 inferomarginals, 1 upwardly curved spine inside furrow, 1–2 large, cylindrical blunt spines on furrow edge, l/w = 3 (4 when cleaned), to 0.8 mm, 5–6 subambulacral spines decreasing in height away from furrow, arranged in 2 transverse rows. Oral plates with large recurved spine apically, 3.0 mm long, 1.0 mm wide, tapering to a sharp point; 3–4 furrow spines, half as high as apical spine, 1–3 suboral spines.

Paratypes. R = 25 and 29 mm, r to 6 mm, br to 7 mm. Largest paratype differs from holotype in having short second row of superomarginal plates proximally and smaller oral spines.

Reproduction. Paratypes with short branched gonads attached at base of arms to lower dorsolateral surface. No eggs apparent.

Colour. (In alcohol) fawn or light orange, ventrally paler, brown tube feet.

Habitat. Unknown.

Distribution. Macquarie Island (69–100 m).

Etymology. Latinised form of the acronym ANARE (Australian National Antarctic Research Expeditions), in recognition of its contribution to this research.

Remarks. The genus *Odontohenricia* Rowe and Albertson, 1988 is distinguished from *Henricia* and other echinasterids by the presence of a large recurved pointed spine at the apex of each jaw. Four species were previously known, all described by Rowe and Albertson (1988). *O. anarea* is closest in form to *O. clarkae*, known

from off South Africa. The holotype of *O. clarkae* was examined for comparison. It is in poor condition with much of the skin and spines removed, R = 33 mm. It differs from *O. anarea* in having slightly thinner arms (br = 6 mm), a finer abactinal skeleton (papular areas typically 0.6–1.0 mm dia.), more numerous but smaller abactinal spinelets (0.25 mm long, 0.04 mm wide), more numerous subambulacral spines (10–13 per plate), and a larger oral spine (to 1.2 mm).

O. hayashii from Japan differs in having thinner arms and a finer skeleton (papular areas appear to be 1.0 mm dia. in Rowe and Albertson, 1988, fig. 10), but otherwise has quite similar abaetinal spinelets and marginal and adambulaeral spines. *O. endeavouri* from off southern Australia has a finer skeleton consisting of stellate plates and isolated tufts of numerous small spinelets. *O. fisheri* from off the North Pacific coast of America has more numerous abactinal, adambulaeral and oral spines.

Specimens of *Odontohenricia* have been misidentified as *Henricia* species in the past. They are often superficially similar and, as more specimens are collected, show the same minor variation in skeletal and spine arrangement that make *Henricia* specimens difficult to identify. One of the current specimens was amongst nine identified as *Henricia obesa* by A.M. Clark (1962). Apart from the lack of an enlarged oral spine, the Maequarie Island specimens of *H. obesa* differ in having a more open skeleton with fewer spinelets and spines.

Order Forcipulatida

Asteriidae

Smilasterias clarkailsa O'Loughlin and O'Hara

Smilasterias sp. cf. *irregularis*.—A.M. Clark, 1962: 87–88.

Smilasterias irregularis.—McKnight, 1984: 143 [non *S. irregularis* H.L. Clark, 1928].

Smilasterias clarkailsa O'Loughlin and O'Hara, 1990: 316, pl. 1f, g.

Material examined. Macquarie Island, off Lusitania Bay, 54°42.7′S, 158°54.50′E, 69 m, 5 Dec 1930, BANZARE stn 83, BMNH 1965.8.5.220 (paratype); 54°23.9′S, 158°59.3′E, 183 m, NZOI stn A698, identified by McKnight (1984) as *S. irregularis*, NIWA(1). ANARE 1986 Expedition, BT2, NMV F53754 (holotype), NMV F53755(paratype); BT3, NMV F53753(paratype). AM 1977–1978 Expedition, Garden Cove (11–14 m), MA-379(1); Caroline Cove (13 m), MA-311(1).

Comparative specimens examined. See O'Loughlin and O'Hara (1990).

Description of material. R = 15–75 mm, r to 13 mm; 5 subcylindrical arms, sometimes shed at base; disc small, disc skeleton reticulate. Abaetinal spinelets spaced in small specimens (R < 40 mm) or grouped in large specimens, cylindrical or capitate, l/w = 2–2.5. Carinal plates raised, quadrilobed, bearing 8 spinelets in a 'V'-shape. To 10 small, narrow dorsolateral plates transversely between carinals and superomarginals, 1–3 longitudinal linkages, up to 6 spinelets per plate, up to 20 spinelets between carinals and superomarginals. Superomarginals cruciform, proximal plates sometimes beaded, to 8 spinelets in 1–2 transverse rows, lower spinelets club-shaped. Inferomarginals usually forming actinolateral margin to arm, 3–4, sometimes 5, flattened, flaring, truncate spines. 2 actinal series on larger specimens, first to three/quarters R, second to quarter R, with 0–3 spines. Adambulaerals with 3, sometimes 4, spines, furrow spine rectangular and chisel-shaped, spines away from furrow truncate and flaring,. Two pairs of oral spines, adoral spines larger than adambulaeral spines. Dense crossed pedicellariae on abactinal, marginal surfaces, to 3 times as numerous as spinelets. Small lanceolate straight pedicellariae abactinally, marginally, aetinally and in furrow. Large incipiently felipedal pedicellariae marginally, actinally and in furrow, each valve with small notch on either side of the hooked tip, largest on disc interradial area. 2 series of large suckered tube feet.

Reproduction. Gonads long (to half R) with short lateral branches or tubercules arranged in 2–3 longitudinal rows, attached at the base of arm on the lower dorsolateral surface; sexes separate, eggs elongate, 0.5–1.0 mm long.

Colour. Tan (in alcohol).

Habitat. The AM Expedition specimens were found on *Codium* adjacent to a dense *Macrocystis* bed, and on a sponge/hydroid mat under a rock overhang.

Distribution. Maequarie Island (11–357 m); South Tasman Rise (620–1650 m).

Remarks. The two large specimens collected by divers on the 1977–1978 Australian Museum Expedition (MA-311, R = 70 mm; MA-379, R = 75 mm) differ from the *S. clarkailsa* types (R to 38 mm) in having grouped abaetinal spinelets, more numerous spines and spinelets, a second row of aetinal plates and no beading on the super-

omarginal plates. These features indicate that *S. clarkailsa* is more elosely related to the subantaretie speeies *S. scalprifera* (Sladen, 1889) than to the Australian speeies *S. irregularis* H.L. Clark, 1928. *S. clarkailsa* is distinguishable from *S. scalprifera* by the density of erossed pedieellariae. This species has been reeently collected from seamounts south of Tasmania (O'Hara, 1998b).

Anasterias Perrier

Anasterias Perrier, 1875: 81.—Fisher, 1930: 221.—Fisher, 1940: 231.—A.M. Clark, 1962: 93.

Sporasterias Perrier, 1894: 107.—Fisher, 1930: 239.

Calvasterias Perrier, 1875: 84.—Fisher, 1930: 225. [New synonymy]

Remarks. Calvasterias was distinguished from *Anasterias* by the increased ealcification of the abactinal skeleton. However, this feature varies within and between different populations of speeies in both genera. *Calvasterias* ineludes four species: *C. asterinoides* Perrier, 1875 the type speeies, supposedly from the Falkland Islands, *C. stolidota* Sladen, 1889 from South America, *C. laevigatus* (Hutton, 1879b) and *C. suteri* de Loriol, 1894 from New Zealand. I have examined adult speeimens from all four speeies (see under *A. directa* below) and find no significant differenee between the skeletons of the last three speeies and the skeleton of pentamerous *Anasterias* specimens from South Ameriea (*A. antarctica*), Kerguelen (*A. rupicola*) and Maequarie Island (*A. directa*). The status of the type speeies is uncertain, as it is unelear as to whether the types were eolleeted from Torres Strait, the Falkland Islands or the Auckland Islands, south of New Zealand (A.M. Clark, 1962: 93–4). The only other known speeimens are also of uncertain origin (A.M. Clark, 1962). These speeimens (BMNH 1844.5.29) are small (R=17–23 mm) with eoarse overlapping skeleton ossieles, redueed papular areas and few earinal or dorsolateral spines. They are similar to some small spinous speeimens of *C. laevigatus* and are possibly members of that speeies. The overlapping skeleton is probably an artefaet of eolleetion and preservation. There is no justifieation for the retention of two genera, *Calvasterias* being a junior synonym of *Anasterias* by page priority.

Anasterias directa Koehler

Plate 2f–h

Parastichaster directus Kochler, 1920: 97–101, pl. xx figs 8–11, pl. xxi figs 8–12, pl. xxiii figs 1, 2, pl. lxii fig. 2.—Rowe and Pawson, 1977: 342.

Sporasterias directa.—Fisher, 1930: 241.—Bennett, 1971, pls 34, 35, 56 fig. 2.

Anasterias directa.—A.M. Clark, 1962: 97, text-fig. 17c.—Simpson, 1982: 43–45, figs 5, 6.—MeKnight, 1984: 143.

Sporasterias antarctica.—Koehler, 1920: 78–79, pl. xviii figs 1–4. [non *A. antarctica* (Lütken, 1857)].

Material examined. (Speeimens marked * are typical of the "*antarctica*" form). Maequarie Island, 10 Oct 1913, Low tide, H. Hamilton, AM J3636(2 syntypes of *P. directus*, the syntypes Koehler labelled "C" and "D" were inadvertently destroyed in, 1939 - see Pawson and Rowe, 1977); H. Hamilton, 1913, identified by Koehler (1920) as *S. antarctica*, AM J3726(11*); Seeluded Beach, 27 Nov 1989, NMV F77766(4), F77767(18*); Garden Cove, Dec 1959, NMV F45010(15), F76254(30*); 15 Dec 1959, F45012(11*); 20 Dee 1961, NMV F76256(1*); 1961, NMV F76252(2*); 31 Mar, 1962, NMV F76267(1); 12 Aug 1962, NMV F76264(4), F76249(40*); 11 Feb 1964, NMV F76263(4), F76253(3*); 16 Jun, 1967, NMV F76262(5); 18 Jun, 1967, NMV F76261(1*); 14 July, 1975, NMV F76266(1); 25 Nov 1989, NMV F76274(1*); 26 Nov 1989, NMV F76273(2); Buckles Bay, 28 Dee 1948, NMV F76248(1 juv*); 16 Jul 1949, NMV F76247(2 juv*); 9 Feb 1950, NMV F76244(1*); Feb 1950, NMV F76242(2*); 8 Dee 1962, NMV F76265(2); Dec 1966, NMV F76270(1 juv); 7 Dec 1986, NMV 76272(1*); Sandy Bay, 7 Feb 1962, NMV F76271(1 juv), F76251(3*); Green Gorge, 24 Jul 1962, NMV F76257(4*); Lusitania Bay, 25 Jul 1962, NMV F76250(4*); Hurd Point, 10 Jan 1962, NMV F76260(1*); Caroline Cove, 10 Jun, 1962, NMV F76258(6*); Aurora Point, 8–9 Feb 1962, NMV F76268(1); Bauer Bay, 8 Oct 1962, NMV F76255(3*); Hasselborough Bay, 19 Dec 1949, NMV F76241(1); Aerial Cove, 2 Dec 1949, NMV F76246(1 juv*); 26 Jan 1950, NMV F76245(4 juv*); 28 Nov 1989, NMV F77768(3), F77769(17*). AM 1977–1978 Expedition, Gorilla Head Rock (8–12 m), MA-142(2), MA-147(1*); Tottan Head, Goat Bay (14 m), MA-39(1), MA-371(1); Tern Rock Bay (7 m), MA-35(4); Garden Cove (1–10 m) MA-14(4), MA-127(4*), MA-359(1), MA-360(1); NE Buckles Bay (intertidal), MA-93(1); Sandy Bay (9 m), MA-224(1); Green Gorge (int-14 m), MA-245(1), MA-247(2), MA-253(8), MA-256(1*), MA-259(1*), MA-280(1*), MA-281(5*); Caroline Cove (8-13 m), MA-300(1*), MA-306(2*); Handspike Point (intertidal–0.5 m), MA-136(4*), MA-138(2); Aerial Cove (0.5–6 m), MA-46(3), MA-47(3), MA-50(3*), MA-83(6), MA-102(2*), MA-107(3), MA-108(4*), MA-109(1), MA-382(4), MA-383(2*), MA-384(1*), MA-386(1), MA-388(8); Anchor Rock (13–20 m), MA-89(1), MA-95(1).

Comparative material examined. A. antarctica (Lütken, 1857): Magellan Strait, Punta Arenas, coll. Schythe, ZMUC(holotype); Chile, Linao, 41°50′S, 73°34′W, BMNH 1975.11.12.6(1); Argentina, Puerto Deseado, identified by Bernasconi, BMNH 1961.7.27.18(1); Golfo RE Concavi, Isla Calburo, identified by Bernasconi, BMNH 1961.7.17.19(1); Magellan Strait,

Fortescue Bay, *Discovery* stn 724, 0–5 m, 16 Nov 1931, BMNH, 1948.3.16.657(10); Cape Horn, St Martins Cove, Ross Antarctic Expedition, BMNH, 1960.4.13.1–2(4). *A. minuta* Perrier, 1875: Falkland Islands, Stanley Harbour, BMNH 1960.5.17.19(1). *A. studeri* Perrier, 1891: Falkland Islands, *Discovery* stn WS91, 191–205 m, 8 Apr 1927, identified by Fisher (1940), BMNH 1948.3.16.662(10). *A. stolidota* (Sladen, 1889): South Chile, Messier Channel, *Challenger*, BMNH(holotype). *C. asterinoides* Perrier, 1875: Falkland Islands (or possibly Auckland Is - see A.M. Clark, 1962), Dr J. Robertson, BMNH 1844.5.29(4). *A. rupicola* Verrill, 1876: Kerguelen, Port Jeanne d'Arc, BANZARE collection 783, identified by A.M. Clark (1962), SAM K1512(62); Greenland Harbour, BANZARE stn 54, BMNH 1965.8.5.251-275(24); Rivett Arm, BANZARE stn 56a, BMNH 1965.8.5.276-281(6); Marion Island, De Villier, BMNH 1973.12.18.4-11(7); BMNH 1973.12.18.12-15(4); Cabbage Point, G. Branch, in *Macrocystis* beds, 12 m , AM J18135(1); Transvaal Cove, G. Branch, in *Macrocystis* beds, AM J18136(1). *A. suteri* (de Loriol, 1894): New Zealand, Lyttelton, Suter, BMNH 1905.1.25.2-3(2); Bodley Head, Oliver, Mortensen's Pacific Expedition, ZMUC(4); Banks Peninsula, Taylors Mistake, E Bennett, BMNH 1952.11.18.4(2); Stewart Island, BMNH 86.11.18.12(1); Snares Island, H.B. Fell, BMNH 1952.4.16.19(1); Campbell Island, Windlass Bay, 23 Jan 1980, AM J22902(2). *A. laevigata* (Hutton, 1879b): Auckland Island, Port Ross, 25 Nov 1914, Mortensen's Pacific Expedition, ZMUC(20); 26 Nov 1914(20); Figure 8 Island, 2 Dec 1914, Mortensen's Pacific Expedition, ZMUC(4); Carnley Harbour, Mortensen's Pacific Expedition, 29 Nov 1914(1); Masked Island, 30 Nov 1914, Mortensen's Pacific Expedition, ZMUC(1); Crozier Point, H.B. Fell, BMNH 1952.4.16.13(3); Tagua Bay, Dawbin, Nov 1943, BMNH 1952.11.18.3(1); Passage Inlet, Dawbin, 24 Jul, 1943, BMNH 1952.11.18.5-7(4); Laurie Harbour, *Discovery* Expedition, BMNH 1905.7.14.6-9(many); Campbell Island, 26 Jan 1980, AM J22906(2); Campbell Island, Filhol, donated Paris Museum 1877, ZMUC(1);

Description of material. R to 60 mm, r to 17 mm. Arms 5, dorsally convex, ventrally flat, widest at base, tapering gradually to a blunt tip. Single madreporite, third to half-way from centre to interradial margin, small, sometimes inconspicuous, often ringed by some spinelets. Anus inconspicuous, central. Arm furrows wide, 4 rows of suckered tube feet.

Dorsal surface covered in thick pustular skin, with clusters of papillae and scattered to clustered low spinelets. Abactinal skeleton reticulate. Abactinal spinelets capitate, sometimes truncate, upper half spiniferous; of various sizes, 0.3–0.8 mm dia, 1–2 times as high as wide. Spinelets largest, widest on disc and proximal arm surfaces. Carinal plates in irregular, often sinuous row; plates square, lobed, L-shaped or irregular in shape, imbricating. Spinelet distribution variable. Some specimens with regular transverse arcs of 3 spinelets on succeeding carinal plates, other specimens more irregular with 1–7, often 1, spinelet on each plate. Up to 7 dorsolateral plates linking carinals and superomarginals in irregular transverse rows, sometimes in regular rows or completely reticulate; plates bar-like or irregular; 1–3 longitudinal linkages proximally, sometimes forming longitudinal rows. 0–1, rarely 2, spinelets on dorsolateral plates, up to 6 present in total between carinals and superomarginals.

Papular areas with clusters of 4–5 papulae in centre, often forming regular longitudinal rows on either side of superomarginal plates, otherwise areas scattered amongst the reticulate skeleton. 1–2 actinal papulae are present between inferomarginal plates.

Superomarginal plates longer than wide, 4-lobed, long ventral lobe, shorter dorsal and lateral lobes, dorsal lobe often not transversely aligned with ventral lobe but displaced toward arm tip, plates imbricate with surrounding dorsolateral, superomarginal, inferomarginal plates. Superomarginal spinelets to 1.0 mm in height, 2–2.5 times as high as wide, 1–3 on each plate, 1–2 spinelets near dorsal lobe, 0–1 smaller spinelets on ventral lobe, rarely some additional very small spinelets, dorsal spinelets form regular longitudinal rows extending from disc to arm tip, ventral spinelets sometimes form a less regular and less extensive row. Inferomarginal plates form an actinolateral margin to arm, wider than long, 4-lobed, dorsal and ventral lobes shorter than lateral lobes, prominent oblique spine-ridge present centrally. Inferomarginal spines thick, capitate, slightly curved, terminally spiniferous, 2–3, rarely 4, per plate, 2.5 mm high, 3–4 times as high as wide, aligned obliquely. Actinal plates bar-like, wider than long, extend almost to arm tip, sometimes 2 series proximally, usually aligned with inferomarginals. Actinal spines, usually 1 per plate, sometimes 2 on proximal plates aligned transversely, often confluent with, but smaller than inferomarginal spines, on larger specimens spine persists to arm tip. 8–10 adambulacral plates to every 3 inferomarginals. Adambulacral spines, one per plate, thinner than inferomarginal spines, 2.5 mm high, 3–5 times as high as wide. On each jaw 2 small oral spines, 2 larger suboral spines, larger than nearest adambulacral spines.

Straight pedicellariae present in arm furrows and on jaw, valves with rounded tips, no teeth; distribution variable, numerous to scarce. Crossed pedicellariae present on dorsal side of inferomarginals, near superomarginals and on lower abactinal surface.

Reproduction (from Simpson, 1982). Separate sexes. Females brood their young from egg to juvenile stage as a cluster under the disc. Eggs are transferred to the brood in July and juveniles are released in October–November. Females adopt an arched posture to hold the brood.

Colour (live). Dorsal surface dark olive green or green brown, sometimes mottled at arm tip, spinelets pale, madreporite white. Ventral surface white, tube feet and tips of adambulacral spines tan. Juveniles pink or orange, egg mass orange.

Habitat. Shore collectors have found this species in sheltered and exposed sites, including intertidal rock pools, rock gutters and boulders, and amongst *Durvillaea* holdfasts. Divers (to 20 m) have also found it on sheltered and exposed rock surfaces, and amongst *Macrocystis* beds. McKnight (1984) has reported one dredged specimen from 55 m.

Distribution. Macquarie Island (0–55 m).

Remarks. The genus *Anasterias* presents considerable difficulties for taxonomists. Many of the nominal species are very variable and ill-defined. There have been many disagreements about synonymies, particularly regarding Magellanic and Falkland Islands species (Fisher, 1940; A.M. Clark, 1962; A.M. Clark and Downey, 1992). Macquarie Island specimens are also very variable in many characters. These include the shape, density and distribution of abactinal spinelets; the rigidity and regularity of the abactinal skeleton; the nature of the abactinal integument, the number of inferomarginal spinelets; and the distribution of the various pedicellariae. Some characters such as the shape of the arm, the density of the skeletal plates and the pustular nature of the skin can vary with preservation. Many of the characters are difficult to quantify and do not lend themselves to traditional morphological analysis.

Koehler (1920) recognised two five-armed species from Macquarie Island: *Sporasterias antarctica* (Lütken, 1857) and *Parastichaster directus* Koehler, 1920. Koehler (1920) did not directly compare the two species, but the understanding of the two genera at that time, indicates that they differed in the regularity of the abactinal skeleton and the density of the abactinal spinelets. Fisher (1923, 1930, 1940) subsequently synonymised the genera *Sporasterias* Perrier, 1894 and *Parastichaster* Koehler, 1920 with *Anasterias*, noting the continuous variation in these features. All subsequent five-armed specimens collected from Macquarie Island have been referred to the species *A. directa.*

Two morphological extremes are recognisable in the current large range of specimens that correspond to Koehler's "species". One form ("*antarctica*") has an irregular abactinal skeleton; a sinuous, irregular carinal series; and 1–2, occasionally 3, carinal spinelets on each plate (pl. 2h). These specimens are broadly similar to the 11 extant specimens of *S. antarctica* identified by Koehler (AM J3726). The other extreme ("*directa*") has a more regular, strongly built dorsolateral skeleton, often with regular longitudinal rows of plates and spinelets (pl. 2g). The carinal plates usually bear three spinelets in a transverse arc, although plates with one or two spines are not rare and other plates can have as many as seven. These features are observable in specimens as small as R = 2 mm. This form is similar to the two extant syntypes of *P. directus.* However, between these extremes there are many variations. Carinal plates with three spinelets can be present on specimens with an irregular skeleton. Sometimes the arrangement of carinal spines can vary on the same animal. Moreover, as listed earlier, many other features vary in a similar fashion in both forms. There is no consistently observable morphological characteristic that can be used to satisfactorily separate the two forms.

Similar morphological differences exist within material from the Magellanic region and from the subantarctic Islands of New Zealand. The extremes have been generally distinguished as species. In the South American region, strongly calcified specimens have been distinguished as *Calvasterias stolidota* Sladen, 1889 or *A. varia* Philippi, 1870 from the more common *A. antarctica.* A further form with a very weakly calcified skeleton, represented in South America by *A. minuta* Perrier, 1875, does not appear to exist at Macquarie Island. A.M. Clark and Downey (1992) have noted the variability of all the Magellanic forms and record only *A. antarctica* as representative of the group. Of the numerous nominal species of *Anasterias* from South America, only *A. studeri* appears to be readily distinguishable from *A. antarctica,* having numerous long abactinal spinelets, triangular straight pedicellariae, and a preference for deep water (< 100 m) habitats (Fisher, 1940; A.M. Clark, 1962; A.M. Clark and Downey, 1992). *A. antarctica* is recorded as being dark green in colour when alive (Madsen, 1955) and broods its young in the typical arched posture. Specimens I have examined have relatively few carinal and dorsolateral spinelets and many specimens, unlike my Macquarie material, have numerous crossed pedicellariae on the marginal and abactinal surfaces.

In the subantarctic Islands of New Zealand, two species are recognised: *A. suteri* with a regular, strongly calcified skeleton and *A. laevigata* with a more weakly calcified skeleton. *A. laevigata* is similar to the Macquarie Island "*antarctica*" form. Mortensen (1925) describes the abactinal spination as being very variable, some animals have an irregular single row of carinal spines and 1–2 irregular dorsolateral rows, others have no carinal or dorsolateral spines at all, rarely a specimen can have 2–3 carinal spines. This variation is also present in some of the specimens I have examined. The distribution of pedicellariae is also very variable. Some specimens have numerous crossed pedicellariae abactinally while others have numbers of straight pedicellariae. Colour is reported as dark green or grey-green with fawn arm tips for adults, and orange for juveniles (H.B. Fell, 1953). Brood juveniles are found between August and November (H.B. Fell, 1953). *A. suteri* on the other hand is clearly distinct having a dense cluster of 4–8 spinelets on each carinal plate. There is one, rarely two, longitudinal rows of dorsolateral spines and 1–2 spines on the superomarginal plates. The colour is fawn-brown or grey-green; brood juveniles have been found in October (H.B. Fell, 1953).

At Kerguelen and Marion Islands, only one five-armed form is recognised: *A. rupicola* Verrill, 1876, which has an irregular abactinal skeleton. No five-armed *Anasterias* species have been found at Heard Island. Specimens of *A. rupicola* from Kerguelen are indistinguishable from the "*antarctica*" specimens from Macquarie Island. Specimens I have examined measure R=9–40 mm and have a sinuous carinal series with 1–3 spinelets. Sometimes carinal spinelets can be arranged in a transverse arc of three spines on at least part of an arm, however, none approach the regular arrangement of the "*directa*" specimens from Macquarie Island. They have up to six dorsolateral spines between the carinals and superomarginals, 1–2 spines on the superomarginal dorsal lobe and one on the ventral lobe, 2–4, usually three, inferomarginal spines and one actinal spine. Two specimens collected in February are arched with traces of brood juveniles around the mouth.

Specimens of *A. rupicola* from Marion Island appear to have relatively few spines. Specimens I have examined have a single carinal spine, 2–3 dorsolateral spines between the carinals and supcromarginals, 1–2 superomarginal and 2–3 inferomarginal spines. Bernasconi (1971) recorded numerous "thick" abactinal spines from his Marion Island specimens, including 3–4 dorsolateral spines transversely. The carinal "lines" were scarcely visible. Live colour is green or orange (Branch et al., 1993). Females start brooding eggs in June to August, young are released in December–January although remnant young continue to be present as late as March; relatively few females brood within a population (Blankley and Branch, 1984).

The two forms from Macquarie Island could represent two closely related perhaps hybridising species or one polymorphic species. However, there appears to be no obvious geographic, bathymetric or ecological premating reproductive isolating mechanism now operating to separate the two forms at Macquarie Island. There is an abundance of morphological intermediates. The two forms have been regularly found from similar sites at the same location. Their reproductive cycles are similar. In the absence of a clear morphological distinction, and without molecular evidence to the contrary, I am referring all the five-armed Macquarie Island *Anasterias* specimens to the single polymorphic species: *A. directa*. Given this interpretation, this species differs from *A. antarctica*, *A. rupicola* and *A. laevigata* by the greater range of variation expressed in the number and distribution of spinelets and the restricted range of variation in the abundance of abactinal pedicellariae. Probably *A. directa*, *A. rupicola* and *A. laevigata* should only be regarded as infraspecific regional forms of *A. antarctica*. It is clear that traditional morphological characters are insufficient to properly differentiate the various taxa in this genus.

Anasterias mawsoni (Koehler)

Plate 2i–k

Stichaster suteri.—Benham, 1909: 32 [non *Calvasterias suteri* de Loriol, 1894].

Parastichaster mawsoni Koehler, 1920: 91–97, pl. xix figs 1–8, pl. xx fig. 1, pl. xxi figs 1–6, pl. xxiii fig. 4, pl. xxiv fig. 5, pl. xxx fig. 5, pl. lxiii fig. 2.—Rowe and Pawson, 1977: 345.

Parastichaster sphoerulatus Koehler, 1920: 101–105, pl. xxi fig. 7, pl. xxiii figs 5–10, pl. xxiv figs 1–4, pl. lxiii fig. 3, pl. lxiv figs 1, 2.—Rowe and Pawson, 1977: 347. [new synonymy]

Sporasterias mawsoni.—Fisher, 1930: 241.—Bennett, 1971, pl. 56 fig. 1.

Sporasterias sphoerulata.—Fisher, 1930: 241.—Bennett, 1971, pl. 56 fig. 2.

Anasterias mawsoni.—A.M. Clark, 1962: 96.—Simpson, 1982: 41–43, figs 3, 4.—McKnight, 1984: 143.

Anasterias sphoerulata.—A.M. Clark, 1962: 96–97.—McKnight, 1984: 143.

Material examined. (Specimens marked * are typical of the "*sphoerulata*" form). Macquarie Island, 10 Oct

1913, AM J3638(4 syntypes of *P. mawsoni*); Oct 1913, AM J3637(2 syntypes of *P. sphoerulatus*); Secluded Beach, 19 Jan 1965, NMV F76177(1); 27 Nov 1989, NMV F76186(7*); Garden Cove, 7 May 1949, NMV F76169(1); Dec 1959, NMV F45009(4 and brood); 15 Dec 1960, NMV F45013(1*); 13 Jul 1962, NMV F76171(1*); 12 Aug 1962, NMV F76175(1), NMV F45109(1); 11 Feb 1964, NMV F76188(2); 18 Jun 1967, NMV F76176(3); 25 Nov 1989, NMV F76184(5*); 26 Nov 1989, NMV F76185(1*); Buckles Bay, 28 Dec 1948, NMV F76165(2); 16 Jul 1949, NMV F76130(2), NMV F76164(2), NMV 76162(1); 9 Feb 1950, NMV F76168(1), NMV F76181(2*); 9 Feb 1952, NMV F76161(2); 8 Dec 1962, NMV F76170(7); 7 Dec 1986, NMV F76180(1); Hasselborough Bay, 31 Mar 1950, NMV F76182(1*); Aerial Cove, 28 Nov 1989, NMV76187(6). AM 1977–1978 Expedition, Gorilla Head Rock (9–12 m), MA-142(2), MA-145(1), MA-146(5), MA-148(1), MA-149(11); Tottan Head, Goat Bay (9–14 m), MA-39(1), MA-42(4*), MA-369(1), MA-371(5), MA-374(5), MA-375(6), MA-376(2 and brood); Tern Rock Bay (7–10 m), MA-35(5*), MA-37(2); Garden Cove (8–14 m) MA-14(11*), MA-15(1*), MA-87(1*), MA-91(1), MA-123(1), MA-124(1), MA-125(2*), MA-127(7), MA-128(6*), MA-379(4); Sandy Bay (9 m), MA-224(1*); Green Gorge (6–18 m), MA-245(4), MA-247(6), MA-250(1), MA-251(2), MA-269(1), MA-275(1), MA-291(2); Caroline Cove (8–13 m), MA-298(2), MA-300(1), MA-306(2), MA-311(8); Aerial Cove (0.5–6 m), MA-46(4), MA-47(20), MA-50(3), MA-56(1), MA-83(8), MA-98(2), MA-100(3), MA-102(6), MA-107(12*), MA-108(7), MA-109(5 and brood), MA-110(5), MA-382(>24), MA-383(2), MA-386(17), MA-388(7), MA-389(4); Anchor Rock (13–20 m), MA-89(3*), MA-90(6*).

Heard Island, Atlas Cove, shore, 28 Dec 1929, BANZARE stn, 19, identified by A.M. Clark (1962) as *A. sphoerulatus*, SAM K1515(2*); 19 May 1949, NMV F76125(1); 11 Sep, 1949, NMV F76127(1 juv); 16 Jan 1950, 30 m, NMV F76124(2); 3 Jul 1950, NMV F76129(9 juv); 16 Aug 1950, NMV F73886(11); 19 Dec 1951, NMV F76128(1); 28 Jan 1952, NMV F76179(1); 8 Feb 1952, NMV F76126(1).

Comparative specimens examined. A. perrieri (Smith, 1876): Kerguelen, Bras Bossiere, 4 m, BANZARE stn 7, SAM K1497(12); BANZARE collection 712, 9 m, 10 Nov 1930, SAM K1508(1).

Description of Macquarie Island material. R to 62 mm, r to 15 mm. Arms 6, dorsally convex, ventrally flat, widest at base, tapering gradually to a blunt tip. Single madreporite, half to two-thirds from centre to interradial margin, small to large, sometimes inconspicuous, sometimes ringed by some spinelets. Anus inconspicuous, central. Arm furrows wide, 4 rows of suckered tube feet.

Dorsal skin thick and pustulate. Abactinal skeleton reticulate. Spinelets capitate, sometimes truncate, upper half spiniferous; often polygonal in cross section if in contact with adjacent spinclets; size variable, 0.4–1.1 mm dia, 1–2 times as high as wide; spinelets largest, widest on disc and proximal arm surfaces. Spinelets arranged in rows around aboard papular areas.

Carinal plates form recognisable longitudinal row down arm; plates irregularly quadrilobed or rhombic, broadly imbricating. Spinelets distribution variable, from being densely clustered on plates, with up to 13 spinelets in 5 longitudinal rows, to scattered with as few as 2–4 diserete spinelets. Dorsolateral skeleton variable, from strongly calcified with block-like imbricating plates to weakly calcified with thin bar-like or trilobed plates; forming transverse rows of up to 7 plates between carinals and superomarginals; forming 1–3 longitudinal rows, the row nearest the carinals most distinct; sometimes reticulate proximally. Dorsolateral plates with 0–3, usually 1–2, spinelets on raised section of plate; forming uni- or biserial rows transversely, with up to 12 spinclets present between carinals and superomarginals, forming irregular rows longitudinally.

Papular areas with clusters of 4–8 papulae, single actinal papulae present between inferomarginal plates.

Superomarginal plates from as long as to longer than wide, irregularly quadrilobed, long ventral lobe, shorter dorsal and lateral lobes, plates imbricate with surrounding plates. Superomarginal spinelets to 1.0 mm in height, 2–2.5 times as high as wide, 2–7, usually 2–3, per plate. Inferomarginal plates forming actinolateral margin to arm, as wide as long, lobed, prominent oblique spine-ridge present centrally. Inferomarginal spines thick, capitate, slightly curved and terminally spiniferous or occasionally flattened and flared; 2–5, usually 3–4, per plate, 2.5 mm high, 2.5–4 times as high as wide. Actinal plates bar-like, wider than long, extend past half R, sometimes 2 series proximally, usually aligned with inferomarginals, with one spine, often confluent with, but smaller than inferomarginal spines. 6 adambulacral plates to every 2 inferomarginals. One adambulacral spine per plate, thinner, smaller than inferomarginal spines, 2.5 mm high, 4–5 times as high as wide, often club-shaped. On each jaw 2 oral and 2 suboral spines; oral spines often short.

Straight pedicellariae present near mouth, in disc interradius, in arm furrows and amongst inferomarginals; size and distribution variable, sometime very numerous or scarce; some valves widened and truncate at tip; minority (typically 10 %) 3-valved, with additional small valve present at right angles to 2 primary valves. Crossed pedicellariae present marginally and dorsally, sometimes in high numbers.

Reproduction. Macquarie Island population with separate sexes. Females brood juveniles under their discs by adopting an arching posture. Broods with up to 296 juveniles. Eggs mature in gonad from July to December until the eggs reach 2.0 mm diameter. Eggs are usually transferred to the brood in January–Febuary and released in May–June (Simpson, 1982). Two specimens in the present collection have brood juveniles in December and January.

Colour. Live Macquarie Island specimens orange, tan, dark brown, purple or green on dorsal surface; spinelets and papulae often paler or different colour; dark stomach caeca visible beneath skin on smaller specimens. Ventral surface cream or white, spines pink or grey, tube feet tan.

Habitat. Present on rock platforms under boulders, or in rock gutters, and subtidally (2–20 m) on sheltered sponges-bryozoan mats, on *Codium*, or under *Macrocystis*. McKnight (1984) reported several dredged specimens from 357 m.

Distribution. Heard Island (0–30 m); Macquarie Island (0–357 m).

Remarks. The six-armed Macquarie Island specimens of *Anasterias* are as variable as the five-armed specimens described above under *A. directa*. The dorsal skeleton varies from being strongly calcified, with block-like plates and a dense covering of polygonal spinelets (pl. 2k), to a more open structure with thin bar-like plates and relatively few discrete rounded spinelets (pl. 2j). The former specimens were described by Koehler (1920) as *P. sphoerulatus* and the latter as *P. mawsoni*. However, there are numerous intergrades between these extremes. Koehler's other distinguishing character for *A. sphoerulatus*, the unusual three-valved pedicellariae, are present on most specimens. The different colour forms do not correlate with skeletal structure or spinelet density. Consequently, I refer *A. sphoerulatus* to the synonymy of *A. mawsoni*.

This species is also common from the littoral of Heard Island. Heard Island specimens show a similar range of variation in the skeleton and spinelets. They also have some three-valved pedicellariae. A.M. Clark (1962) noted the reduced actinal series on BANZARE specimens from Heard Island. This is also a variable feature. Several specimens from Heard Island (NMV F73886) have a well developed primary actinal series extending to the arm tip, and a second series proximally.

The only other six-armed *Anasterias* species is *A. perrieri* (Smith, 1876) from Kerguelen. This species appears to occupy a similar ecological niche at Kerguelen (McClintock, 1985) as *A. mawsoni* at Macquarie Island, but it differs from *A. mawsoni* in having thinner and less numerous spinelets. Specimens of *A. perrieri* that I have examined have no three-valved pedicellariae.

A. mawsoni is not merely a six-armed form of *A. directa*. Besides the differing number of arms, the two species differ in the density of the abactinal spinelets, the colour, and the absence in *A. directa* of three-valved pedicellariae. There is also a time difference of four months between the peak release of brooded young for each species (Simpson, 1982).

Class Ophiuroidea

Key to Macquarie Island Ophiuroidea

1. Disc and arms covered in thick skin concealing any underlying plates or scales unless dried. Arms cylindrical in cross section. Oral papillae and teeth expanded with glassy toothed margin ..... *Ophiomyxa* sp.[a]
— Disc and arms not obscured by skin, although cover of spines may be present. Arms somewhat flattened in cross section 2
2. 2 squarish papillae at apex of each jaw 3
— 1 papilla at apex of each jaw (occasionally an additional oral papillae apical in position, but never 2 squarish papillae) 5
3. 2 low oral papillae on side of each jaw in addition to apical ones, distalmost papilla 2–3 times as long as proximal one ..... *Amphipholis squamata*[b]
— 1 distal oral papilla on each side of jaw, separated from apical one by wide gap 4
4. 6–7 arm spines, lowermost spine considerably longer than the upper spines. Ventral disc surface covered in scales ..... *Amphiura magellanica*
— 4 subequal arm spines. Ventral disc surface naked near oral shields ..... *Amphiura* cf. *angularis*[c]
5. Arms inserted laterally into disc and firmly fused to it. No disc spines 6
— Arms inserted ventrally under the disk, disk margin overlying base of arm .. 9

6. Dorsal arm plates fragmented into 2 lateral plates and several smaller pieces in between. No arm comb ..... *Ophioplocus incipiens*
— Dorsal arm plates entire. Arm comb present 7
7. Disc covered by large circular scales surrounded by smaller plates. 3 minute arm spines, difficult to see ..... *Ophiurolepis inornata*[d]
— Not as above 8
8. Distal arm spines with upturned hook-like ends. Small accessory plates lateral to each proximal ventral arm plate .... *Ophiura (Ophiuroglypha) irrorata*
— Arm spines simple and pointed. No accessory ventral arm plates ....*Ophiura (Ophiura) meridionalis*
9. Dorsal disc plates bordered by rows of spherical granules. Disc margin bordered by row of elongate granules. Arms very slender .... *Ophiolence regulare*
— Disc plates naked or with spines, never with granules 10
10. Apical jaw papillae wider than long, rectangular or tricuspid. 6 arms. Asexually reproduces though fission ..... *Ophiactis hirta*
— Apical papillae longer than wide, usually pointed. 5 arms 11
11. Disc stumps large, cylindrical or club shaped, regularly covered by rows of tiny sharp thorns. Radial shields as wide or wider than long, not covered in plates or stumps ..... *Ophiomitrella conferta*[e]
— Disk spines small, irregular or conical with terminal thorns. Bar-like radial shields largely concealed by disc plates and spines (distalmost end may be exposed) 12
12. Distalmost oral papilla widened. Tentacle scales half the size of the ventral arm plate ..... *Ophiacantha sollicita*[f]
— Oral papillae subequal or proximal papilla slightly enlarged. Tentacle scale almost as long as ventral arm plate ..... *Ophiacantha vilis*

Notes on key:

[a] McKnight (1984: 144) recorded two specimens of an undetermined *Ophiomyxa* species from Macquarie Island (183–415 m). As McKnight pointed out, they share several characteristics of *O. brevirima* H.L Clark, 1915 from New Zealand, including alternating arm spines. On one 7 mm d.d. specimen I have examined (NZOI stn D6, 55°27′S, 158°31.5′E, 415 m), a large rounded upper arm spine is present on some arm segments in addition to the 2 smaller spines. However, unlike *O. brevirima* the dorsal arm plates are entire, bell-shaped and contiguous. The material is not adequate for a complete description.

[b] McKnight (1984: 144) recorded one specimen of the cosmopolitan species *A. squamata* (Della Chiaje, 1828) from Macquarie Island (155 m).

[c] Two specimens of *A. angularis* Lyman, 1879 were recorded by McKnight (1984: 144) from Macquarie Island (NZOI stn D6, 55°27′S, 158°31.5′E, 415 m). I have examined several specimens and they broadly match Lyman's (1882) description and figures (pp. 134–135, pl. XXIX figs 1–3) except that they lack tentacle scales. The disc is naked near the oral shields and orange gonads are visible underneath. They are much smaller (2 mm d.d.) than Lyman's holotype (9 mm d.d.) and the lack of tentacle scales may be a juvenile character or an artefact of preservation. Without a good growth series they cannot be positively identified. *A. angularis* has been recorded from Kerguelen, Heard, Marion Islands, South Africa and New Zealand. However, not all these populations appear conspecific. Mortensen (1936) noted that specimens from South Africa and Kerguelen are sealed on the ventral side of the disc. Branch et al. (1993) have figured a specimen with very long arms. A thorough review is required.

[d] McKnight (1984: 145) recorded one specimen of the widespread deep-water species *O. inornata* (Lyman, 1878) from the south of Macquarie Island (NZOI stn D5, 56°40.6′S, 158°45.5′E, 1280 m).

[e] McKnight (1984: 144) recorded 3 specimens of *O. conferta* (Koehler, 1922b) from the northern Macquarie Ridge (NZOI stn D159, 49°01′S, 164°50′E, 741 m). O'Hara (1990: 299) has recorded this species from off southeastern Australia, Antarctica and the Magellanic region from 40–2340 m.

[f] McKnight (1984: 144) has recorded 28 specimens of *O. sollicita* Koehler, 1922b from two NZOI stations on the northern Macquarie Ridge (NZOI stns D17 and D18, 52°31′S, 160°31′E, 124–128 m). The specimens from NZOI stn D17 have apparently disintegrated (P. Anderson, pers. comm.). Three specimens from stn D18 were examined and compared to the syntypes

from off eastern Tasmania. The Macquarie Island specimens differ in having slightly smaller disc spines (to 0.1 mm, compared to 0.15 mm for the syntypes) which are absent ventrally, and wider ventral arm plates. More material is required to determine if the Macquarie Island specimens represent a distinct species. *O. brachygnatha* H.L. Clark, 1928 from off south-eastern Australia and New Zealand is also similar but has much thinner, moniliform arms and smaller disc spines. O'Hara (1990: 295–296) noted the similarity of *O. sollicita* with the other nominal species from the Atlantic.

Order Ophiurida

Ophiacanthidae

Ophiacantha vilis Mortensen

Plate 3a–c, Figure 4

Ophiacantha vilis Mortensen, 1924: 114–7, fig. 7.—H.B. Fell, 1952: 14.—H.B. Fell, 1958: 25.—McKnight, 1967: 308.

Ophiacantha pentagona.—Madsen, 1967: 59.—McKnight, 1984: 144. [non *O. pentagona* Koehler, 1897]

Material examined. Macquarie Island, off Lusitania Bay, 54°42.5′S, 158°54.5′E, 69 m, 5 Dec 1930, BANZARE stn 83, SAM K947(1). AM 1977–1978 Expedition, Tottan Head, Goat Bay (14 m), MA-371 AM J22265(3), MA-376 AM J22266(1) and AM J22267(6); Garden Cove (10–14 m), MA-123 AM J22258(1), MA-124 AM J22262(1), MA-127 AM J22259(1) and AM J22260(4), MA-128 AM J22261(1), MA-379 AM J22263(1) and AM J22264(4); Buckles Bay (15 m), MA-141 AM J22269(1); Caroline Cove (8 m), MA-300 AM J22268(1); Aerial Cove (6 m), MA-388 AM J22270(1). ANARE 1986 Expedition, BT3 NMV F60293(1), BT10 NMV F60292(1).

New Zealand, Cook Strait, 372 m, 13 Aug 1920, ZMUC(syntype).

Comparative specimens examined. O. imago Lyman, 1878: Kerguelen, Christmas Harbour, 220 m, *Challenger*, BMNH 1882.12.23.318(holotype).

Description of Macquarie Island material. Disc 1–7 mm d.d., arms to > 20 mm. Disc covered in thin imbricating scales, usually bearing 1 small conical or cylindrical stump with 4–8 terminal thorns. Radial shields concealed. Ventral disc stumps smaller, less numerous towards oral shields. Oral shields trapezoid, wider than long, distal lobe often slightly produced. Adoral shields long, narrow, slightly curved, meeting interradially, separated radially. Apical papilla leaf-like, pointed, or irregularly widened on larger specimens; 3, rarely 4, oral papillae, innermost largest, flattened, leaf-like, outer papillae cylindrical, blunt. Dorsal arm plates triangular with convex distal edge, proximal plates just contiguous on larger specimens, other plates separate. Second ventral arm plate triangular, other plates roughly pentagonal with convex notched distal edge, proximal plates wider than long, plates separate throughout. 6, rarely 5 or 7, thick, often finely serrated, bluntly pointed arm spines, uppermost spine longest, on proximal plates enlarged to 1.5 times length of second spine, almost meeting over dorsal midline, lower spines progressively shorter, thinner. Tentacle scale large, almost as long as ventral arm plate, flat, oval or truncate, sometimes terminally thorny.

Reproduction. Viviparous, two specimens (5 mm d.d, NMV F60292; 5.5 mm d.d., AM J22262) with a juvenile in several bursae, other specimens with large orange eggs.

Colour. Dorsal disc and arm surfaces brown or tan, paler ventrally, white arm spines (in alcohol).

Habitat. Diver-collected specimens from Macquarie Island have been found on rocks amongst sponges, red algae, bryozoans and hydroids; one specimen was found on coarse sand.

Distribution. Macquarie Island (6–433 m); New Zealand (90–1090 m); Chatham Rise (241–251 m).

Remarks. Close examination of the Macquarie Island specimens has revealed that they are closer in form to *O. vilis* of New Zealand rather than the Indo-Pacific species, *O. pentagona*, to which they have been previously referred. *O. pentagona* (as described and figured by Koehler 1897 and, 1922a) has minute tentacle scales and slender disc spines with 3–4 long sharp terminal thorns (Koehler, 1922a, pl. 93, fig. 5). In contrast, comparison of a syntype of *O. vilis* (4 mm d.d.) with Macquarie Island specimens of similar size, revealed no significant morphological differences. The syntype of *O. vilis* closely agrees with Mortensen's (1924) description and figures, except that the radial shields are widely separated and disc spines relatively larger than shown on the figures. Photographs of the syntype are reproduced here (pl. 3b, c). The tentacle scales are large, often as long as, or longer than, the ventral arm plate; there are 6–7 finely serrated proximal arm spines and the disc spines are short stumps with 3–4 terminal thorns. There is much variation in the shape of the oral shields in the Macquarie material, particularly in the degree of prominence of the distal lobe. H.B. Fell (1952) has reported a similar variation in New Zealand specimens.

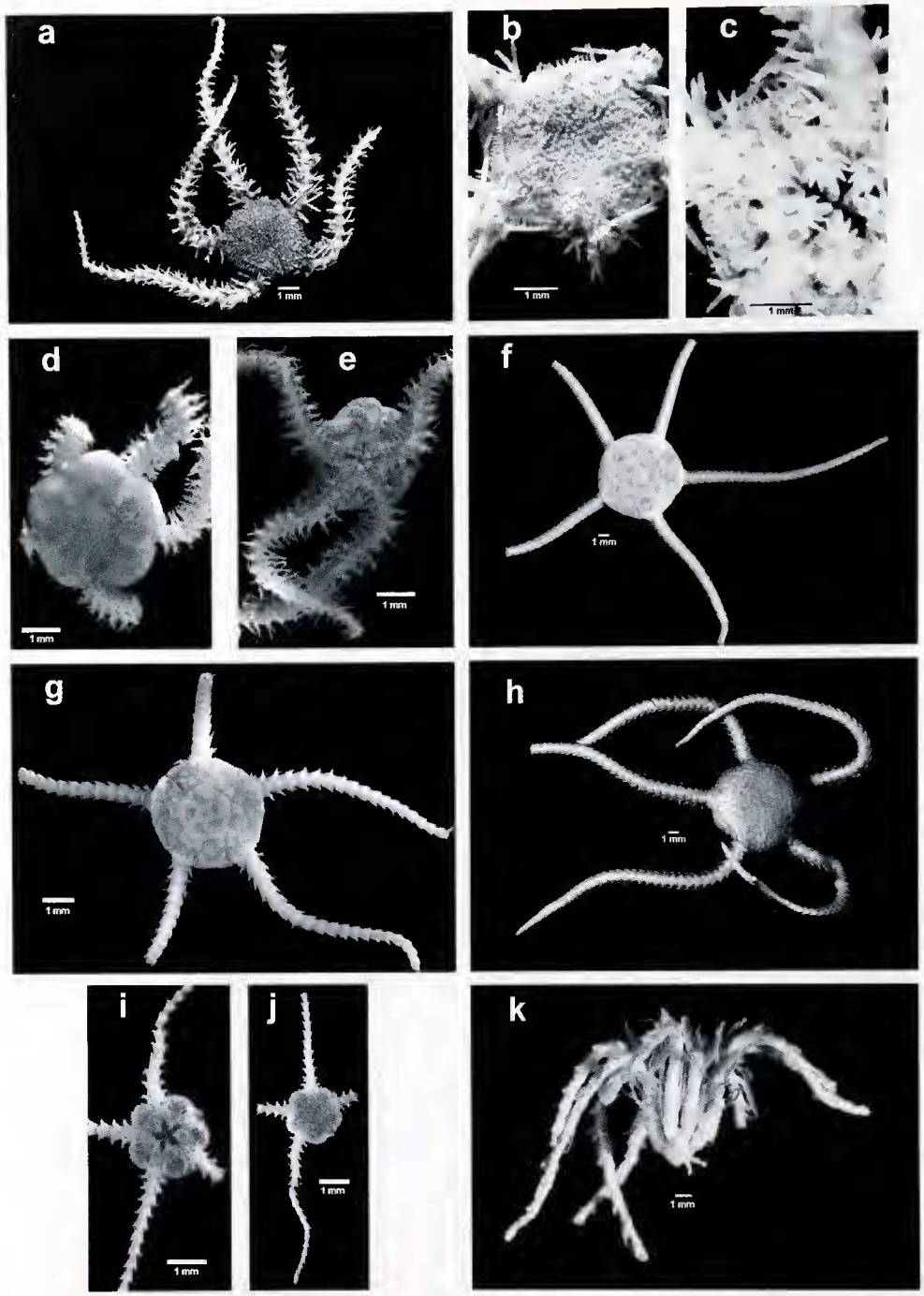

Plate 3. a, *Ophiacantha vilis*, dorsal view, NMV F60293; b, *Ophiacantha vilis*, syntype, dorsal view of disc, ZMUC; c, *Ophiacantha vilis*, syntype, oral view of disc, ZMUC; d, *Amphiura magellanica*, dorsal view (several arms broken), NMV F60294; e, *Amphiura magellanica*, ventral view (one arm missing), NMV F60294; f, *Ophiura irrorata*, dorsal view (arm tips broken), NMV F60298; g, *Ophiura meridionalis*, dorsal view of arm (arm tips broken), NMV F60297; h, *Ophioplocus incipiens*, dorsal view, NMV F60299; i, *Ophioleuce regulare*, ventral view (arm missing from upper right), NMV F60314; j, *Ophioleuce regulare*, dorsal view (arm missing from lower right), NMV F60314; k, *Florometra austini*, lateral view (several arms broken, most cirri lost), NMV F60300.

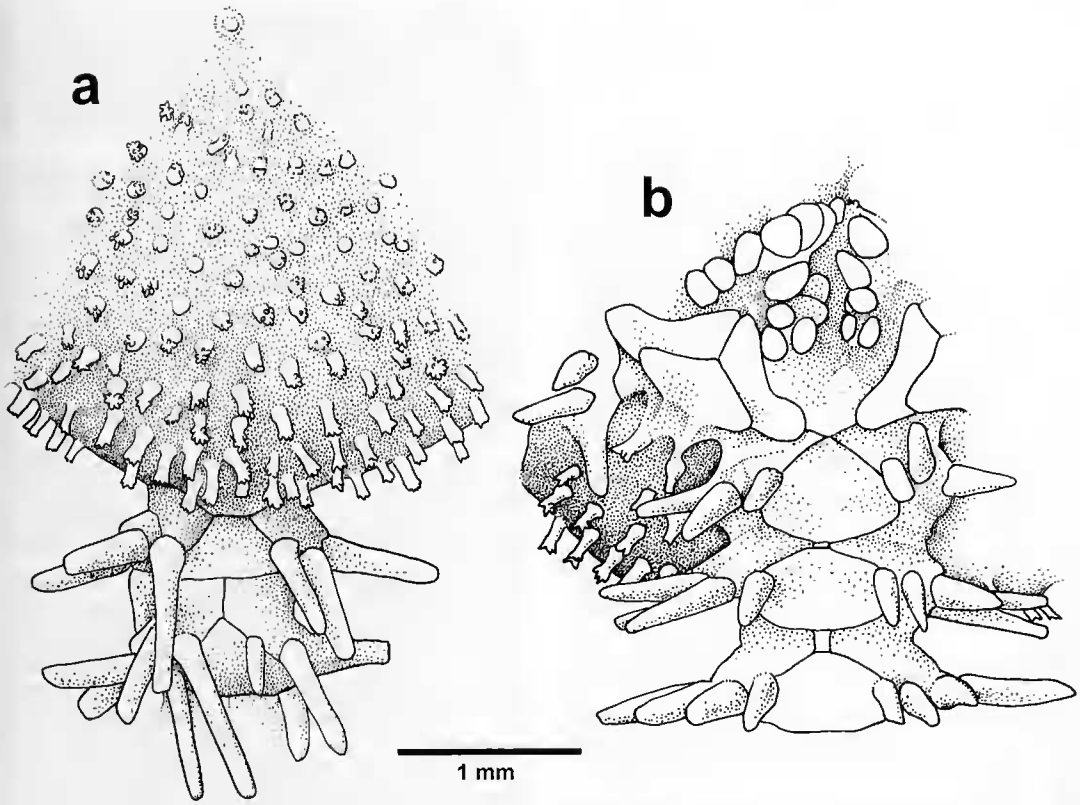

Figure 4. a–b, *Ophiacantha vilis*, NMV F60292: a, dorsal view of base of an arm and adjoining disc; b, ventral view of arm base and adjoining jaws.

There are, however, differences in the reported size, bathymetric distribution and reproductive behaviour between the Macquarie Island and New Zealand specimens. The Macquarie Island specimens grow to 7 mm d.d., while the largest reported New Zealand specimen is 4 mm d.d.. Several obvious growth changes occur in the Macquarie Island specimens. Most notable is the change in disc spines which are relatively shorter, wider and with more thorns on large specimens. Future research may find detectable differences between Macquarie Island and larger New Zealand specimens. The Macquarie Island form is common in the upper subtidal zone (in fact it is the only ophiuroid known above 20 m depth), while the New Zealand form has only been collected below 100 m. This species could prefer the colder water which surrounds Macquarie Island. Finally, the Macquarie Island specimens are viviparous, while H.B. Fell (1958) states that the New Zealand specimens are not. This again could be due to the small size of the New Zealand material. None of the present Macquarie Island specimens under 5 mm d.d. show signs of viviparity. Further evidence is needed to determine if the two populations should be separated into distinct specific or subspecific taxa.

Another similar species, *O. imago* Lyman, 1878, has been recorded from Kerguelen, Marion Island and New Zealand. Examination of the holotype of that species (7 mm d.d.) revealed that it differs from the Macquarie Island specimens in having minute tentacle scales, widely separated dorsal arm plates proximally, longer arm spines, to 3 mm long, and conspicuously thorny distal arm spines. Otherwise it is very similar to the Macquarie Island specimens, particularly in the shape of the disc spines, and it is also viviparous. It agrees closely with Lyman's (1882) description and figures. Whether all the New Zealand specimens referred to *O. imago* belong to that species needs close examination. *O. imago* has not been satisfactory separated from *O. pentagona* and both share the same minute tentacle scale and arm spine number. Very little data on the New Zealand specimens has been published.

Amphiuridae

Amphiura magellanica Ljungman

Plate 3d–e

Amphiura magellanica Ljungman, 1867: 320.—Mortensen, 1924: 132, figs 14, 15a.—Madsen, 1967: 129.—McKnight, 1984: 144 [limited synonymy].

Material examined. Macquarie Island, off Buckles Bay, 54°30′S, 158°58′E, 15 m, 19 Oct 1983, NMV F82954(4); off Lusitania Bay, 54°42.5′S, 158°54.5′E, 69 m, 5 Dec 1930, BANZARE stn 83, SAM K1038(4). ANARE 1986 Expedition, BT2, NMV F76112(1); BT3, NMV F60294(2); BT4, NMV F76222(3); BT5, NMV F60295(1); BT7, NMV F76111(7); BT8, NMV F60296(2).

South America, Tierra del Fuego, *Discovery* stn 1321, identified by Mortensen (1936), BMNH 1936.12.30.531–540(10). Gough Island, *Discovery* stn 399, BMNH 1936.12.30.521–530(12). Auckland Island, Tagua Bay, identified by H.B. Fell (1953), BMNH 1952.11.18.31–32(6).

Comparative material examined. A. spinipes Mortensen, 1924: New Zealand, *Discovery* stn 941, BMNH 1936.12.30.541–550(50).

Description of Macquarie Island material. Disc 2–6 mm d.d.. Disc scales small, 0.1–0.3 mm dia, overlapping, flat. Radial shields, 0.2 times d.d., 5 times longer than wide, separated, divergent centrally. Ventral disc scales smaller, persist until oral shields. Oral shield rounded, usually wider than long. Adorals separated radially and slightly interradially. 2 large block-like infradental papillae; distal oral papilla large oval flat, 2 times higher than wide, larger than infradental papillae. Dorsal arm plates rounded, slightly wider than long proximally, triangular or fan-shaped distally, contiguous. Ventral arm plates rectangular, slightly longer than wide, contiguous. 6–7 arm spines proximally, 4 distally, lowermost spine enlarged, 1.6 mm, up to 3 arm segments in length, slightly curved, second lowest 1 segment in length, uppermost spines smaller, subequal, two-thirds segment in length. Large oval tentacle scale, half to two-thirds arm segment long.

Reproduction. Viviparous, juvenile arms emerging from some bursae of the Macquarie Island specimens.

Colour. Dorsal disc surface grey, arms and ventral surface tan (in alcohol).

Habitat. Macquarie Island specimens collected by divers have been within *Macrocystis* holdfasts (NMV F82954). Mortensen (1924) collected New Zealand specimens from under stones, amongst algal turf, on sand and sandy mud.

Distribution. Southern South America, Falkland Islands Gough Island (0–140 m); Macquarie Island (15–450 m); New Zealand (6–20 m); Auckland and Campbell Islands (0–90 m); southern Australia (220–310 m).

Remarks. These specimens are typical of this species and closely match Mortensen's (1924) description and figures. They are also identical to New Zealand and Atlantic specimens I have examined. *A. spinipes* from New Zealand is morphologically similar, differing only in its more delicate appearance. Mortensen (1924) further distinguished the two species by their reproduction, *A. spinipes* not being viviparous or hermaphroditic.

A. magellanica has been assumed to have a circumglobal subantarctic distribution (Madsen, 1967). Mortensen (1924) suggested epiplanktonic dispersal by drifting *Macrocystis* holdfasts. However, a close examination of its reported range indicates that it has a disjunct mostly cool-temperate distribution with two separate populations, the first around the southern tip of South America and across to Gough Island in the South Atlantic and the second in the Tasman region, including New Zealand, Macquarie Island and possibly southern Australia. The time required to drift on the West Wind Drift current between New Zealand and South America is over two years making epiplanktonic dispersal unlikely (O'Hara, 1998a). Another potential explanation for this distribution is that it reflects vicariant events associated with the break up of the ancient continent of Gondwana (O'Hara, 1998a). However, it is also unlikely that two widely separate populations would retain species integrity over such a long time period and further research may find that the two populations can be distinguished on molecular or developmental grounds

Ophiactidae

Ophiactis hirta Lyman

Ophiactis hirta Lyman, 1879: 39, pl. 13 figs 365–367.—Lyman, 1882: 118–119, pl. 20 figs 4–6.—Mortensen, 1924: 126, figs 12a–c.—H.B. Fell, 1958: 26.—McKnight, 1984: 144–5.

Material examined. Northern Macquarie Ridge, 52°31′S, 160°31′E, 128 m, 23 Apr 1963, NZOI stn D18, NIWA(26).

Description of Macquarie Island material. Disc 1–4 mm d.d., arms 5 times d.d. Arms 6, often 3 arms regenerating following fission. Disc round or pentagonal, disc plates coarse, no obvious primary plates. Radial shields small, D-shaped,

divergent proximally. Few to many small pointed spines on dorsal disc surface. Oral shields diamond-shaped, as wide as long; adoral plates contiguous interradially. One triradiate apical papilla, 2–3 oral papillae. Dorsal arm plate broadly contiguous in larger specimens, rounded distally. Ventral arm plates contiguous, as wide as long, pentagonal with straight distal edge and tapered proximal end. 4 arms spines, upper spine only marginally larger than other; lower spines with swollen thorny tip. Tentacle scale to half the length of ventral arm plate.

Reproduction. The Macquarie material includes specimens asexually reproducing through fission. Division appears restricted to small specimens under 2 mm d.d.. Division fragments have a disk half and three arms. The other half of the disk and three more arms regrow along the division line. It is possible that one specimen has divided twice, having one large, two medium and three small arms. Larger specimens usually have six equal arms. One aberrant specimen has five equal arms, but is otherwise identical. A common disc anomaly is a single large radial shield rather than two smaller plates on a regenerated disc.

Colour. White in alcohol.

Habitat. Australian specimens are known from rock and sand substrates (O'Hara, unpublished data).

Distribution. Northern Macquarie Ridge (124–155 m); New Zealand and the Chatham Rise (222–688 m); southeastern Australia (160–770 m).

Remarks. These specimens are broadly similar to specimens from southeastern Australia. They differ, however, in not having an obviously enlarged upper arm spine, having thorny, swollen tips to the lower arm spines, and slightly larger tentacle scales. Fissiparity is rare in the Southern Ocean. Of the fissiparous species listed by Emson and Wilkie (1980), only the asteroid, *Allostichaster capensis* (Perrier, 1875) is known from south of 40°S, occurring along the southern coast of South America.

Ophiuridae

Ophiura (Ophiura) meridionalis (Lyman)

Plate 3g

Ophioglypha meridionalis Lyman, 1879: 56, pl. xvi figs 447–449; Lyman, 1882: 40.

Ophiura meridionalis.—Mortensen, 1936: 330–332, figs 44a–c, 45.—Madsen, 1967: 131.

Material examined. Macquarie Island, off Lusitania Bay, 54°42.5′S, 158°54.5′E, 69 m, 5 Dec 1930, BANZARE stn 83, SAM K1097(4). ANARE 1986 Expedition, BT3, NMV F60297(2).

Description of Macquarie Island material. Disc 3.5–5.0 mm d.d., arms 3 times d.d.. Disc plates thin, imbricating, primary plates and 2 interradial plates large, other plates small, 0.4 mm dia., 5 from centre to margin. Radial shields small, one-sixth d.d., contiguous. Arm comb papillae small flat rounded, usually contiguous over arm. Ventrally 1, rarely 2, large plates on margin, 6–7 smaller plates. 1–2 pointed apical papillae, 3–4 smaller rounded oral papillae. Distal oral tentacle pore with 3–5 inner, 4–5 outer tentacle scales. Oral shields large, as wide as long, distal sides rounded, proximally pointed. Adorals long and bar-like, meeting interradially, separated radially by large first ventral arm plate. Dorsal arm plates fan-shaped, longer than wide, contiguous proximally, separated distally. Ventral arm plates twice as wide as long, separated throughout. 3 short subequal conical arm spines, 0.3 mm long, third segment long. First tentacle pore with 3 scales, 1 outer and 2 inner, second with 1–2 scales, inner scale small and rim-like, other pores with 1 scale incompletely covering pore.

Reproduction. This species is viviparous and a hermaphrodite; male and female gonad separate; eggs 0.3–0.4 mm dia, 6–8 young in a bursa (Mortensen, 1936).

Colour. White in alcohol.

Distribution. Off eastern South America (1098–1890 m); South Georgia, Falkland Islands (60–249 m); Antarctica, off Enderby, Kemp and Princess Elizabeth Lands (193–1266 m); Macquarie Island (69–135 m).

Remarks. The present specimens closely match Mortensen's (1936) description and figures of this species. *O. meridionalis* has an unusual distribution. It has been found in the Antarctic and Magellanic regions, but not at other subantarctic locations besides Macquarie Island. The record of *O. meridionalis* from off the Vestfold Hills, Eastern Antarctica (Tucker and Burton, 1987, pl. 14, fig. 30) is incorrect. The specimen (TM H1975) is an *Ophiomusium* species.

Ophiura (Ophiuroglypha) irrorata Lyman

Plate 3f

Ophioglypha irrorata Lyman, 1878: 73, pl. 4 figs 106–108.—Lyman, 1882: 47–48, pl. 5 figs 7–9.

Ophiuroglypha irrorata.—Pawson, 1969: 52–54, figs 2e–f, 8–13.—McKnight, 1984: 145.

Ophiura irrorata.—Madsen, 1967: 130.
Ophiura (Ophiuroglypha) irrorata irrorata.—Paterson, 1985: 123–124, figs 46, 47.

Material examined. Macquarie Island, ANARE 1986 Expedition, BT8, NMV F60298(6). Campbell Island, 58°07′S, 169°13′E, 526 m, NMV F52670(6).

Description of Macquarie Island material. Disc 6–9 mm d.d., arms (with broken tip) 3.5 times d.d. Disc plates coarse, imbricating; primary plates prominent; large circular plates to 1.1. mm dia. exist midway to margin in each interradial and radial axis; wide oval plates, 0.9 x 1.6 mm, are present in each interradial margin; other disc plates small, 0.3–0.6 mm dia. Radial shields an irregular triangle or rectangle, contiguous distally, separated proximally by several disc plates, to 1.8 mm long. Arm comb papillae short, rounded, not contiguous dorsally over arm, dorsal papillae longest. Genital slits extend from adoral shields to disc margin, bordered by small papillae. Oral shields roughly pentagonal, longer than wide with acute proximal angle and rounded distal edge. Adorals small, separated radially by first ventral arm plate. 3–5 papillae on jaw apex, to 5 squarish papillae on each jaw side, smaller than apical ones, distalmost papillae rarely widened. Dorsal arm plates contiguous for two-thirds of arm, fan-shaped with rounded distal edges, as wide as long proximally, narrower distally. Ventral arm plates contiguous for first 3–4 plates, first 2–3 plates squarish, fourth plate triangular, others widely separated, 2–3 times as wide as long. Second oral tentacle pore opens into jaw slit, elongate with 5 inner and 8 outer scales. Pores decrease rapidly in size over the next 6 plates, 4 inner and 5 outer scales on first arm pore, 2 and 3 on next 2 plates, reducing to 1 scale. Small supplementary plate on outer distal corners of arm segments 1–4. 3 small, peg-like arm spines, to 0.3 mm long, dorsal spine little separated from other two. Middle spine modified into upturned hook on distal arm segments.

Reproduction. Unknown.

Colour. Tan in alcohol.

Habitat. Mud (Lyman 1882); rock (Pawson, 1969; McKnight, 1984).

Distribution. Cosmopolitan (71–5870 m); Macquarie Island (71–450 m).

Remarks. These specimens are broadly similar to those described by Pawson (1969) from New Zealand, except that Pawson's specimens differ in having supplementary arm plates that persist until the arm tip and low widened distalmost oral papillae. *O. irrorata* is a very polymorphic species (Paterson, 1985) and these differences do not appear significant. Six specimens from off Campbell Island were examined for comparison (NMV F52670). These are smaller (to 4.5 mm d.d.), but similar to the Macquarie specimens and also lack distal supplementary arm plates after the fifth arm segment. Pawson (1969) noted that his specimens could be distinguished from other *O. irrorata* material by the coarseness of the disc plates and may represent a new species. In many ways the Macquarie Island specimens are similar to *O. mundata* (Koehler, 1906) (as described and figured by Paterson, 1985) from the north Atlantic. However, *O. mundata* has no supplementary arm plates. Madsen (1967) noted that *O. irrorata* is cosmopolitan in abyssal seas, extending into the sublittoral in the Southern Ocean.

Ophioplocus incipiens (Koehler)

Plate 3h

Ophioceres incipiens Koehler, 1922b: 48, pl. 84 figs 1–6, 13–14.—Mortensen, 1936: 307.—H.B. Fell, 1961: 69, pl. 1a fig. 3, pl. 2a fig. 1, pl. 3 fig. 2, pl. 9 fig. 2.—Madsen, 1967: 137.—Pawson and Rowe, 1977: 352.—Baker and Devaney, 1981, figs 3, 6–9.
Ophioplocus incipiens.—Thomas, 1975: 239–240.

Material examined. ANARE 1986 Expedition, BT6, NMV F60299(1).

Description of Macquarie Island material. Disc 9 mm d.d., arms > 35 mm. Disc scales small, 0.25 mm dia, imbricating, 15 scales from centre to margin, primary plates evident. Radial shields small, 0.8 mm long, oval, widely separated. Ventral disc plates smaller, genital slit 1 arm segment long. 4 oral papillae and 1 underlying oral tentacle scale on jaw edge. Trapezoid oral shields, adorals meet interradially, separated radially by small first ventral arm plate. Dorsal arm plates fragmented, proximally into 2 large outer fragments separated by 2–3 smaller central fragments, distally the 2 larger fragments joined at the distal end and 2–3 smaller fragments are confined to proximal end. Ventral arm plates pentagonal, convex distally. 2, sometimes 3, stout flattened pointed arm spines, lowermost longest, half segment long, 0.6 mm long. 2 tentacle scales, large oval scale on lateral arm plate, smaller rim-like scale on ventral arm plate.

Reproduction. Protandric hermaphrodite, viviparous (Mortensen, 1936).

Colour. Macquarie specimens (in alcohol) tan.

H.B. Fell (1961) recorded live colour as blue-grey or purple disc with cream or pinkish-yellow arms.

Habitat. Polyzoa (H.B. Fell, 1961)

Distribution. Antarctica, off Enderby, MacRobertson, Princess Elizabeth, King George V Lands, Ross Sea (110–603 m); South Georgia, South Shetland, Clarence Islands (60–342 m); Macquarie Island (25–29 m).

Remarks. The discovery of *O. incipiens* at Macquarie Island is surprising as it has been previously reported only from Antarctic waters. A closely related species is found in the subantarctic islands of New Zealand. This was originally referred to *O. huttoni* (Farquhar, 1899) but Baker and Devaney (1981) restricted the known distribution of *O. huttoni* to the northern island of New Zealand, recognising *O. marginata* (H.B. Fell, 1953) as the southern and subantarctic New Zealand species. Baker and Devaney (1981) distinguished *O. marginata* from *O. incipiens* by the shorter arms, only twice d.d., and the relatively simple pattern of dorsal arm plate fragmentation.

Ophioleuce regulare (Koehler)

Plate 3i–j

Ophiopyren regulare Koehler, 1901: 26, pl. VIII figs 52–54.

Ophiopyren regularis.—Madsen, 1967: 129.—McKnight, 1984: 145.

Ophioleuce regulare.—Madsen, 1983: 45–48, figs 7a–g [full synonymy].—O'Hara, 1990: 293–294.

Material examined. Macquarie Island, off Lusitania Bay, 54°42.5′S, 158°54.5′E, 69 m, 5 Dec 1930, BANZARE stn 83, SAM(13). ANARE 1986 Expedition, BT4, NMV F60314(1).

Description of Macquarie Island material. 1.5–5.0 mm d.d., arms delicate, slender, mostly broken, approx. twice d.d., triangular in cross section. Disc slightly convex dorsally, ventrally flat or concave; plates large, 0.6 mm long, mostly bordered by 1–4, usually 2, rows of spherical granules; margin tapers to sharp edge, bears several rows of elongate pointed granules. No granules ventrally. Oral shields pentagonal, as wide as long, distal edge overlain by ventral disc plates. Adoral shields contiguous interradially, separated radially by ventral arm plates. 1 elongate pointed apical papilla, 5–7 oral papillae, inner elongate, others low flat rounded, distal 1–2 papillae function as outer scales of second oral tentacle pore, opposed by 1–2 inner scales on first ventral arm plate. Dorsal arm plates with convex distal edge, contiguous proximally, some slightly carinate. Ventral arm plates rhombic or triangular, contiguous until just outside disc margin. 2 small pointed arm spines. Proximal tentacle pores elongate with 1–3 inner and 1–2 outer scales, distal pores round with 1 flat oval scale.

Reproduction. Sexes separate (Mortensen, 1936).

Colour. White in alcohol.

Habitat. Mortensen (1936) speculated that this species lives attached to stones or other hard substrates.

Distribution. Circumpolar Antarctica (100–900 m); South Georgia (160 m); Macquarie Island (65–438 m); southeastern Australia (770–841 m).

Remarks. The present specimens closely match the full description given by Madsen (1983).

Class Echinoidea

Key to Macquarie Island Echinoidea

1. Primary spines numerous, secondary spines similar but shorter and evenly distributed over the test ..... *Pseudechinus novaezealandiae*
— Primary spines few and very large, secondary spines much smaller, distributed in wreathes around the primary spines and in rows up the ambulacra 2
2. Apical primary spines with prominent basal and terminal discs .... *Goniocidaris parasol*[a]
— Apical primary spines with small terminal cup-like discs and basal spurs .... *Goniocidaris umbraculum*[a]

Notes on key:

[a] Two cidaroid echinoids have also been reported from near Macquarie Island. Pawson (1968a: 13–15, fig. 1.1) and McKnight (1984: 145) recorded *Goniocidaris umbraculum* (Hutton, 1879a) from the northern Macquarie Ridge (NZOI stns D17 and D18, 52°31′S, 160°31′E, 124–128 m, 23 Apr 1963). F.J. Fell (1976) recorded *Goniocidaris parasol* H.B. Fell, 1958

from *Eltanin* Cruise 16, stn 1411 also on the northern Macquarie Ridge (51°00′S, 162°01′E, 333–371 m, 8 Feb 1965). *G. parasol* is distinguished from *G. umbraculum* by the presence of basal and terminal discs on the apical primary spines. On the holotype of *G. parasol* (see H.B. Fell, 1958: 32–34, pl. 3 fig. b, pl. 5 fig. b) these discs are very large and join together to form a complete shielding system over the aboral surface. However, F.J. Fell (1976) found that not all specimens have terminal discs and that basal discs do not develop until a horizontal diameter of 20 mm is reached. As Pawson's (1968a) specimens were small, < 19 mm diameter (McKnight supplied no data for his specimens), it cannot be determined if one or two species of *Goniocidaris* occur around Macquarie Island. F.J. Fell (1976) also records both species and the similar species "*Austrocidaris*" *pawsoni* McKnight, 1974 and *Ogmocidaris benhami* Mortensen, 1921 from the subantarctic islands of New Zealand. Both *G. parasol* and *G. umbraculum* are known to brood their young (Barker, 1984).

Order Temnopleuroida

Temnopleuridae

Pseudechinus novaezealandiae (Mortensen)

Plate 4a–b

Notechinus novaezealandiae Mortensen, 1921: 153, pl. 6 figs 7–10, pl. 7 figs 4, 5, 7–11.—Koehler, 1926: 36, pl. 54.

Pseudechinus novaezealandiae.—Mortensen, 1943: 237, figs 117–118, 120b, 121b, 126c.—Pawson, 1968a: 15–16, fig. 1(2).—Bennett, 1971, pl. 56, fig. 5.—Simpson, 1982: 50.—McKnight, 1984: 145.

Material examined. Macquarie Island, Garden Cove, 1957, NMV F60309(1); 14 Jul 1963, NMV F60310 (1); 5 May 1965, NMV F60311(1); opposite Gadget Gully, 1 Jul 1962, NMV F60312(1). ANARE 1986 Expedition, BT2, MNV F60304(6); BT3, NMV F60302(4); BT4, NMV F60305(3); BT6, NMV F60303(1); BT10, NMV F60301(3). AM 1977–1978 Expedition, Gorilla Head Rock (9 m), MA-148(1); Tottan Head, Goat Bay (14 m), MA-371(2), MA-374(1), MA-375(3); Tern Rock Bay (10 m), MA-37(1); Garden Cove (8-14 m), MA-14(3); MA-87(4), MA-123(1), MA-124(3), MA-125(3), MA-127(2), MA-128(11), MA-379(2); Sandy Bay (16 m), MA-241(6); Green Gorge (0.5–18 m), MA-245(10), MA-246(1), MA-247(11), MA-248(1), MA-251(11), MA-267(1), MA-281(1), MA-291(1), MA-292(1), MA-294(4); Caroline Cove (13 m), MA-306(3); Aerial Cove (5 m), MA-52(2), MA-107(1). *Eltanin* Expedition, 54° 31.0′S, 159° 00.0′E, 110 m, 12 Feb 1965, cruise 34 stn 2215, USNM(1).

Description of Macquarie Island material. Horizontal diameter to 51 mm, 36 mm high. Test shape hemispherical, oral side flattened, circumference round, slightly sunken perisome. Spines short, to 7 mm, coarse and dense; not curved at perisome. Primary ambulacral spines form regular series, their tubercules sometimes confluent. Secondary spines, their tubercules half diameter of primary spines, form longitudinal rows in median area, and also present among pore pairs. Interambulacral areas closely covered in spines, some secondary tubercules almost as wide as primary ones, forming 1–2 rows inside each primary series. Apical system small, one-sixth test diameter, plates closely tuberculate. Ocular 1 insert, other oculars exsert. Periproct oval, anal opening posterior. Complete circle of larger plates border periproct, smaller elongated plates border anal opening. Perisome naked. 2 types of globiferous pedicellariae, larger ones with short robust valves, with 1–3 teeth on each side, smaller ones with 1 tooth on each side. Tridentate pedicellariae small inconspicuous, valves with narrow serrated edges.

Reproduction. Separate sexes, female gonads large, with numerous small eggs (0.08–0.1 mm). The larval stage is probably planktonic (Mortensen, 1921; Simpson, 1982).

Colour. Macquarie Island specimens (live) with grey, green or brown test, dark green spines, with white, grey or occasionally violet tips.

Habitat. On Macquarie Island it is found rarely by shore collectors in deeper rock pools or as beach drift. Divers (2–20 m) have found it mainly on sponge-bryozoan mats, sheltered rock surfaces, or sometimes amongst the holdfasts of *Desmarestia* and *Macrocystis*. Common in dredged samples to 433 m. Pawson (1968a) recorded this species from rock and sand substrata.

Distribution. South Island of New Zealand (0–100 m); Auckland, Campbell, Bounty and Antipodes Islands, Campbell Rise (0–306 m); Macquarie Island (0.5–433 m).

Remarks. *P. novaezealandiae* is the most common echinoid from Macquarie Island as well as southern New Zealand (Pawson, 1968a). *P. marionis* (Mortensen, 1936) from Marion Island, Kerguelen and Gough Island differs in having slender white spines, a white or greenish test, and much larger suranal plates than *P. novaezealandiae*. *P. magellanicus* (Philippi, 1857) from the Magellanic region and Tristan da Cunha has a red test and spines.

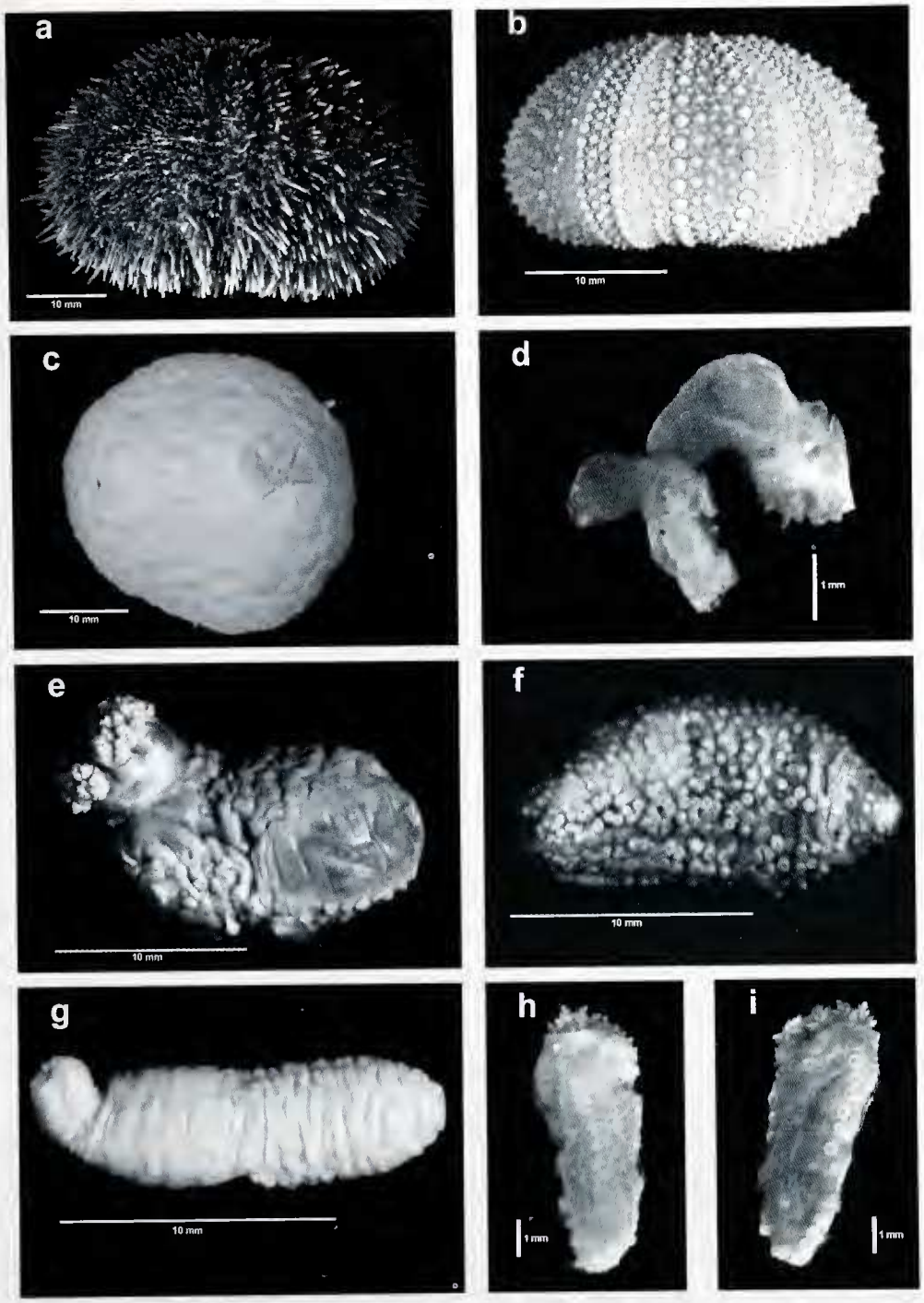

Plate 4. a, *Pseudechinus novaezealandiae*, lateral view, NMV F60309; b, *Pseudechinus novaezealandiae*, lateral view of test, NMV F60312; c, *Psolus neozelanicus*, dorsal view, NMV F60306; d, *Taeniogyrus dunedinensis*, NMV F77775; e, *Pseudopsolus macquariensis*, lateral view, NMV F76189; f, *Trachythyone macphersonae*, dorsolateral view, NMV F76113; g, *Pseudocnus laevigatus*, dorsolateral view, NMV F76118; h, *Trachythyone nelladana*, holotype, dorsal view, NMV F83072; i, *Trachythyone nelladana*, holotype, ventral view, NMV F83072.

Class Holothuroidea

Key to Macquarie Island Holothuroidea

1. Tube feet present 2
— No tube feet 9
2. 10 dendritic (branched) tentacles; shallow water and shelf species 3
— 15–20 disc, quadrilobed or shield shaped tentacles; bathyl species 8
3. Tube feet mostly absent from the dorsal surface (1–2 may be present anteriorly), ventral sole present 4
— Tube feet common on dorsal surface 6
4. Dorsal surface covered in thick leathery skin, few ossicles, pedicles in 3 rows on all ventral radii ..... *Pseudopsolus macquariensis*
— Dorsal surface covered by imbricating plates or scales. Midventral radius without tube feet except at each end or rarely in middle 5
5. Dorsal surface covered in large scales; up to 6.0 mm long, body flattened, mouth and anus dorsal in position ..... *Psolus neozelanicus*
— Dorsal surface covered in imbricating plates (0.3–0.5 mm long); mouth and anus anterior/posterior in position ..... *Trachythyone nelladana* sp. nov.
6. Tube feet scattered on dorsal surface, not restricted to radii ..... *Trachythyone macphersonae*
— Tube feet restricted to radii 7
7. Cup ossicles present, ventral pair of tentacles reduced in size ..... *Ocnus calcareus*[a]
— Cup ossicles absent, plate ossicles "pine-cone" shaped, denticulate end constricted into definite neck. 10 equal sized tentacles ..... *Pseudocnus laevigatus*
8. Body soft; 15 disc shaped tentacles, dorsal papillae apparently absent; ossicles concave wheels of 2 types, largest with 10 or more spokes and ventral rods finely spinous along their length ..... *Laetmogone* sp.[b]
— Body firm; 19–20 quadrilobed tentacles; pedicels restricted to double row on posterior section of midventral radius; few scattered processes on expanded dorsolateral margin of body; ossicles with 4 subequal elongate processes ..... *Paelopatides ovalis*[c]
— Body flaccid; 20 shield shaped tentacles, tube feet in 2–4 rows on ventral radii, dorsal surface with 6 rows of papillae; ossicles cruciform plates with 3–4 bifurcated or perforated arms and central pillar ..... *Synallactes challengeri*[d]
9. Wheels ossicles present; skin smooth or wrinkled but not papillate ..... *Taeniogyrus dunedinensis*
— Wheels rare or absent; anterior body wall with papillae ..... *Taeniogyrus* sp.

Notes on key:

[a] McKnight (1984: 145) recorded the New Zealand species *Ocnus calcareus* (Dendy, 1896) (Cucumariidae: Dendrochirotida) from three NZOI stations off Macquarie Island (71–433 m). I have re-examined holothurians from one of the stations (D10) and found only three species: *Trachythyone macphersonae, Pseudocnus laevigatus*, and *Taeniogyrus dunedinensis*. As there is no indication with the material whether it includes all McKnight's specimens, further confirmation is required of the existence of an *Ocnus* species from Macquarie Island. Mortensen (1925: 335) recorded *O. brevidentis* (Hutton, 1872) from Macquarie Island but suspected that the locality label was an error.

[b] A single damaged specimen of an undescribed *Laetmogone* species (Laetmoginidae: Elasipodida) was collected south of Macquarie Island by the *Eltanin* expedition (56° 19.2′S, 158° 29′E, 833–842 m, 12 Feb 1965, cruise 16, stn 1422, identified by M. O'Loughlin, USNM E27630). This species also occurs on the seamounts south of Tasmania (M. O'Loughlin, pers. comm..) in depths of 1580–1700.

[c] A single specimen (130 mm long) of *P. ovalis* (Walsh, 1891) (Synallactidae: Aspidochirotida) has been recently trawled near Macquarie Island (54° 46.2′S, 158° 42′E, 930–815 m, 17 Jan 1995, identified by M. O'Loughlin, NMV F80184). This species is otherwise known from bathyl depths (911–1611 m) off the Andaman Islands in the Indian Ocean and east of Cape York in the Coral Sea (M. O'Loughlin, pers. comm.).

[d] A single damaged specimen of *S. challengeri* (Théel, 1886) (Synallactidae: Aspidochirotida) was collected off Macquarie Island by the *Eltanin* expedition (54° 31.0′S, 159° 00.0′E, 110 m, 12 Feb 1965, cruise 34, stn 2215, identified by M. O'Loughlin, USNM E47579). This species also occurs off Crozet, Marion and Prince Edward Islands (237–600 m) (Massin, 1992) and off

Order Dendrochirotida

Psolidae

Psolus neozelanicus Mortensen

Plates 4c, 5a–b

Psolus neozelanicus Mortensen, 1925: 362–363, figs 44, 45.—Pawson, 1970: 28.

Psolus antarcticus.—Pawson, 1968a: 19–21, fig. 2(1–4).—McKnight, 1984: 145.—O'Hara, 1998a: 146. [non *Psolus antarcticus* (Philippi, 1857)]

Material examined. Macquarie Island, ANARE 1986 Expedition, BT2, NMV F76117(1); BT3, NMV F60306(9). *Eltanin* Expedition, 54° 30.0′S, 158° 59.0′E, 112–124 m, 15 Feb 1967, cruise 27 stn 1974, USNM E33647(1).

New Zealand, 2 miles east of North Cape, 102 m, 2 Jan 1915, Mortensen, ZMUC(2 syntypes of *P. neozelanicus*).

Description of Macquarie Island material. Up to 50 mm long, 40 mm wide, 10 mm high; body flattened, limpet-like, mouth and anus dorsal, mouth highest point, tapering on all sides to thin sharp margin. Tentacles 10, ventral pair smaller, dendritic. Anus and mouth each with 5 large triangular valves. Dorsal surface covered in large imbricating scales. Several rows of smaller scales surround margin, mouth and anus, and lie scattered between larger scales. No dorsal tube feet. Conspicuous flattened ventral sole with 2 rings of tube feet, those on outer ring (on margin of larger specimens) are small and sparse, those on inner ring (several mm from margin) are larger and form biserial or zigzag row; few tube feet at each end of midventral radius on larger specimens. Calcareous ring plates robust with concave posterior edge and slender anterior process; 1 polian vesicle

Dorsal ossicles large multi-layered perforated scales up to 6.0 mm long (body length 38 mm), to 2.5 mm long on smaller specimens (body length 12 mm). Scales with several small grain-like projections on the dorsal surface, 0.15 to 0.25 mm wide, consisting of the same multi-layered framework as the scale body. No cups. Ventral ossicles scattered knobbed perforated buttons. Buttons with 4 large central holes and 4–20 smaller peripheral holes, up to 30 scattered small knobs, jagged margins, up to 0.11 mm long (pl. 5a–b). Tube feet each with typical ventral ossicles, slightly concave, up to 0.25 mm wide, with up to 33 perforations. Tentacles with perforated plates of 3 types: 1) triangular shaped to narrow/bent plates with numerous perforations and denticulate margin, typically 0.16 mm long; 2) flat irregular plates with 4–6 large perforations, typically 0.12 mm long; 3) smaller finer plates, square, slightly concave, numerous small perforations, typically 0.08 mm long (digit endpieces).

Reproduction. Sexes separate, gonads consisting of numerous long unbranched tubules, gonopore dorsal, posterior to mouth; numerous eggs in female gonad tubules, average size 0.5 mm dia. Mortensen (1925) reported egg sizes of 0.2 mm in his small specimens.

Colour. Macquarie Island material (in alcohol) brown or pale dorsal surface, pale sole.

Habitat. Several specimens (NMV F60306) were found attached to dead shells of the scallop *Chlamys patagonica delicatula* (Hutton); also recorded from rock (Mortensen, 1925).

Distribution. New Zealand (102 m); Macquarie Island (91–415 m).

Remarks. The Macquarie Island *Psolus* material appears conspecific with *P. neozelanicus* rather than *P. antarcticus* as proposed by Pawson (1968a). *P. neozelanicus* is only known from the two small type specimens from North Cape, New Zealand (length 7–10 mm). These specimens have the same grain-like projections on the dorsal scales as the Macquarie Island material. These projections possibly function in a similar fashion to cup ossicles. The types lack the small outer tube feet, however this is also true of smaller Macquarie Island specimens (≤ 13 mm body length) . The larger type specimen has lateral margins that are coiled ventrally giving the body an atypical cylindrical shape, probably an artefact of preservation (Mortensen, 1925). A similar body form occurs on two small (9–13 mm length) Macquarie Island specimens (NMV F60306). *P. antarcticus* from the Magellanic region is very similar except it appears to lack the small grain-like projections on the dorsal scales; instead its scales have been described as smooth or very finely granulated (Théel 1886). Pawson (1968a) distinguished *P. neozelanicus* from *P. antarcticus* by the presence of several rings of small dorsal scales surrounding the anus and

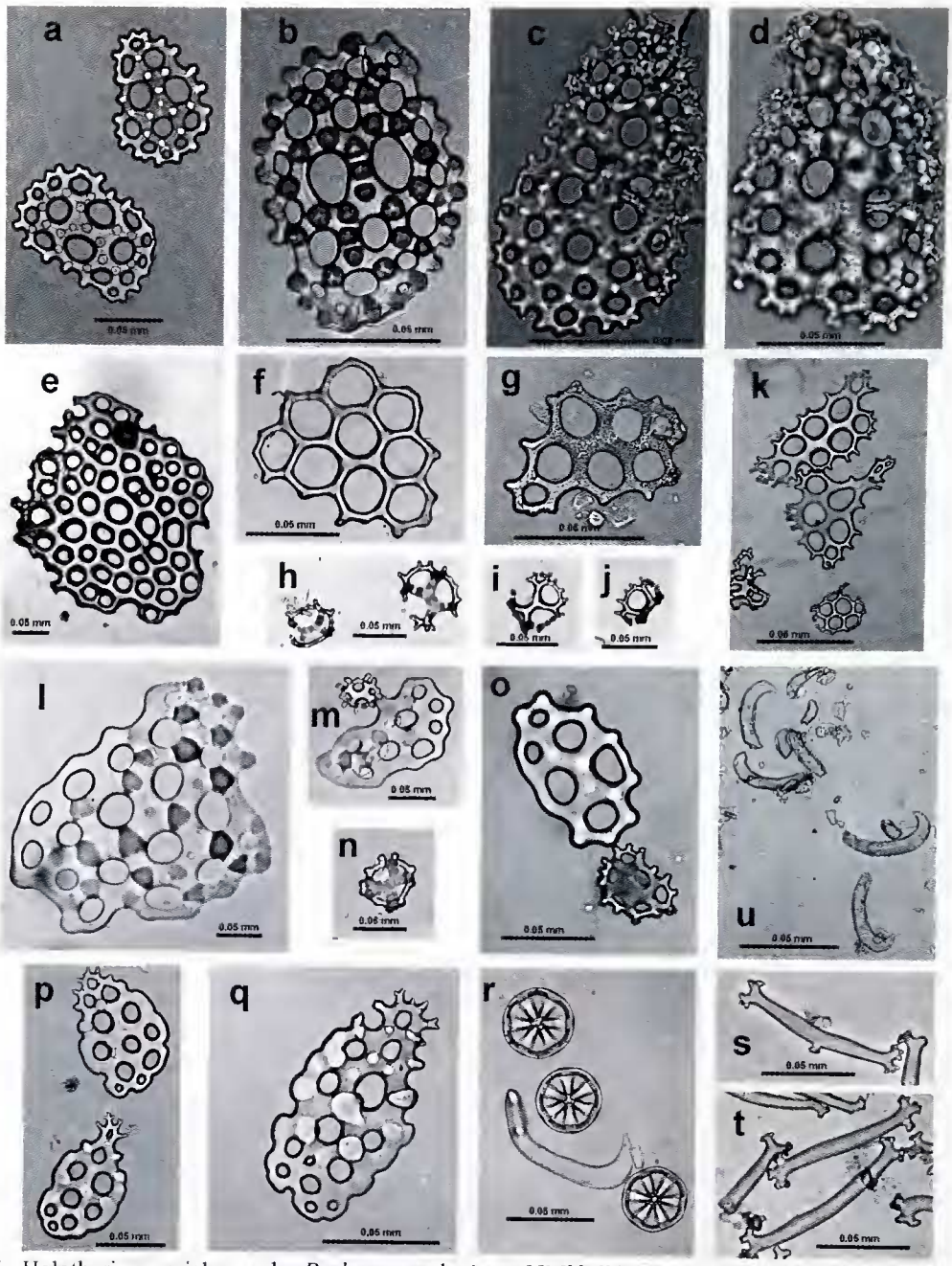

Plate 5. Holothurian ossicles. a–b, *Psolus neozelanicus*, NMV F60306, ventral knobbed plates; c–d, *Pseudopsolus macquariensis*, NMV F76198, dorsal ossicles, showing incipient secondary network in centre of plates; e–k, *Trachythyone nelladana*, NMV F77770: e, dorsal plate; f–g, plates from sole; h, dorsal cups, view from above; i, dorsal cups, view from below; j, dorsal cups, view from side; k, tentacle ossicles; l–o, *Trachythyone macphersonae*: l, dorsal plate from juvenile, NMV F77772; m, dorsal plate and cup (viewed from below) from adult, NMV F77773; n, dorsal cup from juvenile (viewed from above), NMV F77772; o, dorsal plate and cup (viewed from above) from adult, NMV F76116; p–q, *Pseudocnus laevigatus*, NMV F76118, body wall plates; r–t, *Taeniogyrus dunedinensis*: r, sigmoid hook and wheels from body wall, NMV F77775; s, tentacle ossicle with lateral process, NIWA; t, tentacle ossicles, NIWA; u, *Taeniogyrus sp.*, sigmoid hooks, AM J22904.

greater number of perforations on the sole ossicles. However, these features vary in the Macquarie Island material. Both species are distinguished from related Australasian and Southern Ocean species by the lack of a continuous row of midventral tube feet and the presence of only five large anal and oral valves (Pawson, 1968a).

Cucumariidae

Pseudopsolus macquariensis (Dendy)

Plate 4e, 5c–d

Psolus macquariensis Dendy, 1896: 41, pl. 7 figs 70–72.

Pseudopsolus macquariensis.—Pawson, 1968b: 143–144, fig. 1 [full synonymy].—Pawson, 1970: 38.—Bennett, 1971, pl. 32.—Simpson, 1982: 45–48, figs 7–9.

Material examined. Macquarie Island, Secluded Beach, 27 Nov 1989, NMV F76189(3); Garden Cove, 5 Dec 1960, NMV F45003(16); 12 Aug 1962, NMV F76190(3); 17 Jan 1964, NMV F76200(10); 16 Jun 1967, NMV F76191(2); 14 Mar 1969, coll R.D. Simpson, AM J8177(12); 25 Nov 1989, NMV F76192(9); 26 Nov 1989, NMV F76193(6); Buckles Bay, 7 Dec 1986, NMV F60307(3 juv); 8 Dec 1986, NMV F60308(2); Nugget Point, 15 Dec 1962, NMV F76194(1); Hurd Point, 29 Jan 1964, NMV F76195(1); Bauer Bay, 27 Jan 1967, NMV F76196(3); Hasselborough Bay, 23 Aug 1962, NMV F76197(8); Hasselborough Point, 24 Jan 1964, NMV F76199(2); Aerial Cove, 28 Nov 1989, NMV F76198(5). AM 1977–1978 Expedition, Tern Rock Bay (7 m), MA-35(1); Garden Cove (1–10 m), MA-14(5), MA-356(33), MA-360(69); NE Buckles Bay (intertidal), MA-93(100); Green Gorge (intertidal–0.7 m), MA-255(1), MA-256(2), MA-258(2), MA-259(2), MA-281(1), MA-282(5).

Description of Macquarie Island material. Up to 40 mm long and 16 mm wide (AM J8177), body barrel-shaped, with a tapered anus (unless fully contracted), anus and mouth slightly dorsally upturned. 10 equal tentacles, dendritic, each with 4 major bushes on pronounced stalk. Mouth in centre of large oral disc. Introvert thick and muscular. Dorsal body wall covered in thick smooth leathery skin, dorsal radii sometimes visible. Conspicuous ventral sole, skin notably thinner than on dorsum. Dorsal tube feet restricted to 1–2 small ones on introvert. Ventrolateral radii with 1–3 rows of tube feet, outer row largest. Midventral radii with 1–2 rows of pedicles, often tube feet in each row placed alternately, in zigzag arrangement. Pair of knotty protuberances are present midventrally on specimens collected in late winter-spring.

Dorsal ossicles perforated plates, varying in density from scarce to abundant and overlapping, typically 0.08–0.14 mm long, with 2–4 large central perforations and smaller peripheral perforations, small knobs, sometimes coalescing into secondary layers, margins denticulate (pl. 5c–d). No tube foot or tentacle ossicles.

Reproduction. Macquarie Island material usually with separate sexes, but with some specimens showing successive hermaphroditism. Two compartmentalised brood sacs are present with an opening to the exterior. Large eggs (to 1.8 mm dia) develop in ovaries from December to June. In May–June, eggs are transferred to the brood sacs, possibly by an external process. Release of juveniles occurs in late September–October, apparently in a highly synchronised fashion (Simpson, 1982).

Colour. Macquarie Island specimens (live) with dorsal surface coloured light to dark brown, reddish or purplish; introvert, tentacles, anal cone and sole sometimes paler. Brown spots sometimes present between tentacles.

Habitat. Lower intertidal pools and rock surfaces (0–1 m), subject to wave action, sometimes exposed at low tide; amongst *Durvillaea* holdfasts, sometimes on coralline algae or *Codium.* Only two of the current 295 specimens were collected from subtidal depths (7 and 14 m).

Distribution. Macquarie Island (0–14 m).

Remarks. This species is very common on rocky substrates in the lower intertidal zone. The sole is used to adhere strongly to the substrate and the tentacles are extended into the surf. Pawson (1968b) described internal anatomy in detail. Simpson (1982) noted the pair of protuberances which appear on the ventral body surface, near the openings to the brood sacs, on specimens collected during the juvenile release period in spring. In this collection they are present in specimens collected as early as August. Their function is unknown.

P. macquariensis gruai has been described from Kerguelen by Cherbonnier and Guille (1975). Kerguelen specimens are similar to Macquarie specimens in overall morphology and habit. They appear to differ in having ossicles in the tube feet and tentacles, and possibly in their developmental biology. Cherbonnier and Guille (1975) described the gonads as being very long and fine, with relatively few eggs measuring 1µm in diameter. A record of *P. macquariensis* from Stewart Island south of New Zealand is

probably a locality error (Mortensen, 1925; Pawson, 1970).

Pseudocnus laevigatus (Verrill)

Plates 4g, 5p–q

Pentactella laevigatus Verrill, 1876: 68.

Cucumaria laevigata.—Ludwig and Heding, 1935: 179–185, fig. 43.

Pseudocnus laevigatus.—Pawson, 1968b: 145, figs 2–11 [full synonymy].—Bennett, 1971, pl. 56 fig. 6a.—Simpson, 1982: 48.

Pseudocnus leoninoides.—Pawson, 1968a: 22. [non *P. leoninoides* (Mortensen, 1925)]

Material examined. Macquarie Island, Garden Cove, 26 Dec 1965, I. Bennett, det. Pawson, F45102(1); 26 Nov 1989, NMV F76119(1); off Buckles Bay, 54°30′S 158°58′E, 15 m, 19 Oct 1983, NMV F82953(8); Aerial Cove, 28 Nov 1989, NMV F76118(1); 54°40′S, 159°01′E, 71 m, NZOI stn D10, NIWA (3). AM 1977–1978 Expedition, Gorilla Head Rock (11–12 m), MA-146(2); Tottan Head, Goat Bay (2.4–14 m), MA-39(1), MA-41(1), MA-365(2), MA-371(9), MA-374(11), MA-375(9), MA-376(16); Tern Rock Bay (7 m), MA-35(6); Garden Cove (6–14 m), MA-14(2), MA-91(4), MA-123(1) MA-124(8), MA-125(23), MA-127(5), MA-128(18), MA-350(1), MA-379(19); Sandy Bay (15–16 m), MA-237(2), MA-241(57); Green Gorge (6–18 m), MA-245(7), MA-247(8), MA-248(3), MA-250(4), MA-251(3), MA-267(1), MA-275(3), MA-289(1), MA-291(1), MA-292(13), MA-294(7); Caroline Cove (8–18 m), MA-298(7), MA-300(2), MA-306(3), MA-307(2), MA-311(2); Handspike Point (intertidal), MA-136(2); Aerial Cove (0–6 m), MA-46(2), MA-47(14), MA-50(8), MA-54(2), MA-55(1), MA-83(12), MA-85(65), MA-86(1), MA-98(1), MA-102(35), MA-107(54), MA-108(100), MA-109(12), MA-110 (30), MA-382(10), MA-383(1), MA-386(155), MA-388(4), MA-389(15); Anchor Rock (13–20 m), MA-89(21), MA-95(6). ANARE 1986 Expedition, BT2, NMV F76120(5); BT3, NMV F76121(14); BT4, NMV F76122(3); BT5, NMV F76123(2). *Eltanin* Expedition, 54°24′S, 159°01′E, 10 Feb 1965, 79-93 m, cruise 16, stn 1417, USNM E43134(5); 54°31.0′S, 159°00.0′E, 18 Jun 1968, 110 m, cruise 34, stn 2215, USNM(1).

Description of Macquarie Island material. Body cylindrical, up to 35 mm long (preserved). Preserved material often highly contracted, with body wall becoming thick and wrinkled or body becoming twisted. 10 equal tentacles. Introvert very long and thin when extended. Ventral and dorsal body surface similar, no sole. Pedicels restricted to radii, in 1–2 zigzag rows, extending from anus to anterior end, including across introvert. Body wall dense with small pine-cone shaped ossicles (pl. 5p–q). Ossicles 0.08–0.15 mm long, 0.075–0.14 mm wide, with 4–5 large central and smaller peripheral holes, covered in large knobs, one end attenuated and denticulate. Denticulate end orientated externally giving body surface a rough texture. Some rare x-shaped plate precursors, 0.03 mm long. Plates slightly smaller ventrally. Introvert ossicles irregular perforated plates, few knobs. Tube feet plates narrow and bent, widened centrally and attenuated at each end, large perforation in centre; end pieces 0.15–0.27 mm dia. Tentacle ossicles are 2 kinds of perforated plates, irregular shapes, large plates typically 0.2 mm long, occasionally knobbed, smaller plates finer, 0.7 mm long.

Reproduction. Sexes separate. Gonads short unbranched tubules. Females with few eggs in each gonad; Macquarie Island specimens with eggs in November to 0.7 mm dia; Kerguelen specimens with eggs in January to 1.4 mm dia (Pawson, 1968b). Eggs transferred to brooding sacs in November. A pair of brooding sacs are attached on either side of the ventral midline in the posterior half of the animal. The sacs are invaginations of the body wall opening to the exterior through a vestibule with a slit-like aperture (Pawson, 1968b). Brood juveniles in December measure 3 mm long, with a few tube feet on the radii, visible tentacles and scattered ossicles in the body wall. Simpson (1982) found up to 93 young in the internal brood pouches of a specimen 35 mm long from Macquarie Island (no date supplied). Small juveniles are present in samples from December to February, which may have been free living or expelled from the brood sacs during collection of adults.

Colour. Macquarie Island material (live) light pink to orange-pink with distinct brown dots on the tentacle trunks and at the bases of the pinnae. Marion Island specimens white or orange (Pawson, 1971).

Habitat. Macquarie Island: sublittoral, under rocks or sheltering between encrusting sponges or the green alga *Codium*, within *Macrocystis* holdfasts, and rarely on sand. Can be locally numerous under sheltered rock overhangs. Marion Island specimens recorded from rock, gravel, sand and sand with mud (Branch et al., 1993).

Distribution. Marion Island (0.5–240 m); Crozet, Kerguelen, Heard Islands (0.5–275 m); Macquarie Island (0.5–135 m). Théel (1886) recorded one small specimen from 1023 m south of Crozet Island (as *Cucumaria serrata* var. *marionensis*).

Remarks. P. laevigatus is a polymorphic species or species complex that has been reported widely throughout the subantarctic. The shape of the

ossicles can vary from the typical "pine-cone" shape, present at Macquarie Island, to elongated plates found on animals near Heard Island, to being very irregular at Kerguelen (M. O'Loughlin, pers. comm.). Théel (1886) attempted to separate regional varieties of this species (as *Cucumaria serrata*) but these have been abandonned by later researchers. However, similar forms from South America and New Zealand are known as *P. perrieri* (Ekman, 1927) and *P. leoninoides* (Mortensen, 1925) respectively.

Pawson (1968a) recorded a single specimen of *P. leoninoides* from NZOI station D18, 150 miles NNE of Macquarie Island (52°31′S, 160°31′E, 128 m, 24 Mar 1963, NIWA). Pawson (1970) suggest that further material may reveal that the Macquarie specimen represents a different species. M. O'Loughlin (pers. comm.) who has examined this specimen believes its affinities lie more with *P. laevigatus* than *P. leoninoides*. *P. leoninoides* is known from the rocky shallows of Campbell, Auckland and the Snares Islands and apparently differs from *P. laevigatus* in lacking brood pouches (Mortensen, 1925). Material referred to both *P. laevigatus* and *P. leoninoides* requires revision.

Trachythyone macphersonae Pawson

Plates 4f, 5l–o

Trachythyone macphersonae Pawson, 1962: 47, pl. 1 figs 1–5.—Pawson, 1968b: 147–149, figs 12, 13.—Bennett, 1971, pl. 56 fig. 6b (upper figure is probably *P. laevigatus*).—Simpson, 1982: 48.

Material examined. Macquarie Island, Garden Cove, 26 Dec 1959, NMV F45001(holotype); Dec 1963, NMV F76116(4); 12 Aug 1962, NMV F76115(4); 25 Nov 1989, NMV F76114(1); 26 Nov 1989, NMV F76113(3); north coast, under rock in pool, Dec 1965, I. Bennett, ident. Pawson, NMV F45104(6); Buckles Bay, 8 Dec 1986, NMV F77777(1); off Buckles Bay, 54°30′S, 158°58′E, 15 m, 19 Oct 1983, NMV F82952(25); Aerial Cove, 28 Nov 1989, NMV F76110(5); 54°40′S, 159°01′E, 71 m, NZOI stn D10, NIWA(7). AM 1977–1978 Expedition, Tottan Head, Goat Bay (9–14 m), MA-369(1), MA-371(2), MA-376(2); Tern Rock Bay (1–10 m), MA-34(1), MA-35(6); Garden Cove (3–14 m), MA-92(5), MA-350(2), MA-354(18), MA-379(8); Sandy Bay (15–16 m), MA-237(5), 241(45), 242(4); Green Gorge (0.5–18 m), MA-245(4), MA-247(2), MA-248(7), MA-251(8), MA-267(2), MA-281(6), MA-292(1), MA-294(13); Caroline Cove (8–18 m), MA-300(4), MA-306(8), MA-307(1), MA-311(2); Handspike Point (intertidal), 136(4); Aerial Cove (0.5–6 m), MA-46(2), MA-47(8), MA-50(3), MA-83(13), MA-85(2), MA-98(1), MA-102(106), MA-108(26), MA-109(1), MA-110(10), MA-382(14), MA-386(261), MA-387(4), MA-388(18), MA-389(29); Anchor Rock (20 m), MA-89(13). ANARE 1986 Expedition, BT2, NMV F77773(6), BT3, NMV F77771(1), BT4, NMV F77772(3).

Description of material. Body (preserved) up to 65 mm long, 10 mm wide (AM stn MA-50). Body cylindrical, 10 short dendritic tentacles, orientated anteriorly, ventral pair reduced. Anus on small posterior cone or taper, surrounded by 5 small valves and some small tube feet. Scattered dorsal tube feet. Ventral tube feet slightly larger, restricted to radii, in 2 rows midventrally, and 1–2 rows ventrolaterally, rarely with 3 rows. Ventral skin thinner, distinct, no true sole. No tube feet on introvert. Juveniles (3 mm d.d.) with 1–2 tube feet on each ventral radius, few smaller tube feet scattered dorsally.

Dorsal ossicles massed flat perforated plates, overlain by cups. Small specimens have large plates to 0.3 mm long (rarely to 0.37 mm) with numerous knobs, up to 35 holes (pl. 5l). Knobs occasionally coalesce into incipient secondary layer. Plates often overlap to form rigid crystalline body wall. Large specimens with smaller plates, 0.06 to 0.23 mm long, with 2–13 holes, few small low knobs (pl. 5m, o). A few flat x-shaped ossicles present, possibly plate precursors. Cups oval-shaped with smooth cruciform base and spined rim, spines directed up away from cruciform piece (pl. 5m-o). Rim formed by coalescing ends of developing cruciform piece, typically to 0.05 mm long and 0.04 mm wide, slightly wider than deep. Cruciform pieces without rims or cups with incomplete rims sometimes found. Cups more numerous in adults. Ventral ossicles plates and cups, plates smaller, finer, more irregular than dorsal plates, 0.15 to 0.25 mm long. Introvert ossicles small thin plates with fine knobs and large perforations, to 0.25 mm long and 0.1 mm wide. Tube feet with endplates (0.3 mm dia) surrounded by a series of irregular narrow, bent or triangular perforated plates, typically 0.27 mm long 0.07 mm wide, sometimes with ends or 1 edge strongly denticulate. Tentacles with elongate curved knobbed perforated plates, typically 0.2 mm long and 0.04 mm wide, and smaller irregular perforated plates with large holes and few knobs, typically 0.07 mm long and 0.05 mm wide.

Reproduction. Sexes separate. Gonads a cluster of short tubules. Females with few relatively large eggs, typically 0.2 to 0.35 mm dia (Simpson, 1982 recorded eggs up to 0.8 mm dia.), eggs evident in specimens from all months sampled

(July to February), no evidence of brooding in the current specimens.

Colour. Body and introvert (live) pink or mauve; anal cone and tube feet light orange; tentacles dark orange with distinct brown dots at tentacle bases.

Habitat. Sublittoral, under rocks or sheltering amongst encrusting sponges, anemones or the green alga *Codium*, common within *Macrocystis* holdfasts. Locally numerous under sheltered rock overhangs.

Distribution. Macquarie Island (0.5–135 m).

Remarks. Many species of *Trachythyone* described from the Southern Ocean are ill-defined and require revision. The ossicles of the various species can change with age and some ossicle types may be missing from old or poorly preserved specimens. *T. macphersonae* is similar to material of *T. parva* described by Panning (1964) and Hernandez (1982) from off Chile and the Falkland Islands (0–180 m) and may be conspecific. Both species have knobbed plates and cups, with large plates (pl. 5l) and few cups in juveniles and smaller plates (pl. 5m, o) overlain by numerous cups in adults. Whether these specimens are conspecific with the types of *T. parva* is uncertain as Ludwig's (1875) inadequate description of the ossicles in the type translates as "large perforated plates" and "small x-shaped cups". Some specimens of *T. macphersonae* have a few incomplete x-shaped cups consisting only of the concave cruciform piece. Specimens from Kerguelen, originally recorded as *T. parva* by early workers, were redescribed as *T. ekmani* by Ludwig and Heding (1935) on the basis that they possessed cups instead of x-shaped plates. On the other hand Cherbonnier and Guille (1975) suggested that *T. ekmani* is no more than a ecological race of *T. parva*. Possibly *T. parva*, *T. ekmani* and *T. macphersonae* represent a single widely-dispersed subantarctic species. A revision will require fresh material of several size classes collected from throughout the subantarctic.

Trachythyone nelladana sp. nov.

Plates 4h–i, 5e–k, Figure 5a

Material examined. Holotype, Macquarie Island, ANARE 1986 Expedition, off Nugget Point, 54°33.4′S, 158°56.9′E, 108–135 m, 8 Dec 1986, stn BT3, NMV F83072.

Paratypes, type locality and date, NMV F77770(10).

Description. Holotype 10 mm long, 4 mm wide, 3 mm high. Body dome shaped with convex dorsal surface and flattened sole. Mouth orientated anteriorly, 10 dendritic tentacles, ventral pair reduced. Small thin introvert. Posteriorly orientated anus. No dorsal tube feet, except pair of minute ones at anterior margin. Sole present, surrounded by ring of about 25 large tube feet, tube feet denser near anterior and posterior ends, isolated midventral tube foot occasionally present, skin of sole very thin. No obvious anal or oral valves. Calcareous ring with 5 radial and 5 interradial pieces, each with incised anterior projection and posterior notch; radials larger with smaller anterior incision.

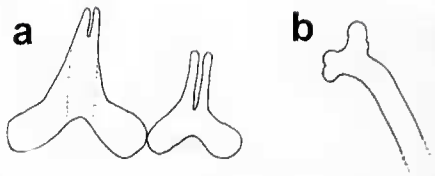

Figure 5. a, *Trachythyone nelladana*, NMV F77770, radial and interradial plate of calcareous ring. b, *Taeniogyrus* sp., AM J22904, tentacle ossicle fragment.

Dorsal ossicles consist of several layers of overlapping perforated plates overlain by cups. Plates up to 0.55 mm, approximately 30 plates between anus and introvert on largest specimen, up to 50 perforations per plate in regular arrangement (pl. 5e), no knobs, some larger plates with ventral thickenings or arches. Cups oval, with thick cruciform piece and spinose rim, typically 0.05 mm long, 0.04 mm wide, 0.04 mm deep, rim often incomplete (pl. 5h–j). Ventral ossicles small buttons with 2–8 large holes, margin with small rounded knobs, up to 0.1 mm dia (pl. 5f–g). Tube foot ossicles elongate perforated rods surrounding end plate, end plate 0.3 mm dia. Tentacle ossicles flat perforated plates, quadrangular, typically with 10 perforations and denticulate margin, to 0.12 mm; some plates slightly concave; other plates elongate, 3 times as long as wide, with larger perforations (pl. 5k).

Paratypes 4–11 mm in length, similar morphology and ossicles as holotype.

Colour. Tan/white, pale (preserved).

Reproduction. Female caeca in December with long slender unbranched moniliform tubules (one half the body length) containing scattered ovoid eggs 0.15 to 0.25 mm long.

Habitat. Unknown.

Etymology. Latinised form of the name of the former polar vessel *Nella Dan* from which these specimens were collected.

Distribution. Macquarie Island (108–135 m).

Remarks. These specimens are intermediate between the Psolidae and Cucumariidae having the clearly defined sole of a psolid (thin skin, mainly peripheral tube feet and small ventral ossicles) and the small single-layered plates, well-developed cups and terminal mouth/anus of a cucumariid. Both families contain species that lack dorsal tube feet. I am placing this species in the Cucumariidae on the basis of the ossicles present. However, the Cucumariidae is possibly paraphyletic, the psolids representing an extreme development of cucumariids with imbricating dorsal plates.

I am reluctant to create a new genus for these animals as the Cucumariidae is badly in need of revision and generic limits are unclear (O'Loughlin and O'Hara, 1992). The ossicles, flat imbricating plates and cups, are similar to those found in *Trachythyone* species. It is clearly distinguished from all other *Trachythyone* species in lacking dorsal pedicels. Species within the Cucumariidae that lack dorsal tube feet include *Ocnus farquhari* Mortensen, 1925 and *O. sacculus* Pawson, 1983 from New Zealand. These species differ from the *T. nelladana* in having multi-layered ossicles, knobbed buttons and rows of tube feet on all three ventral radii. Other cucumariid genera that lack dorsal tube feet include *Microchoerus* Gutt, 1990 which has small knobbed plates that diminish with age and lacks cups; *Neocnus* Cherbonnier, 1962 and *Pseudopsolus* Ludwig, 1898 which have few body wall ossicles.

The new species can be differentiated from species of *Psolus* by the terminal mouth and anus, the flat single-layered dorsal plates, the well-developed cup ossicles (absent in the sole), and the flat reduced ventral plates. Several other species have a similar body form, including *P. charcoti* Vaney, 1906, *P. murrayi* Théel, 1886, and *P. granulosus* Vaney, 1906 from the Southern Ocean. The body shape of *P. granulosus* is most similar to the current species. However, this species has multi-layered dorsal scales, knobbed ventral plates and lacks true cups. Both *P. charcoti* and P. *murrayi* are large cylindrical animals with a small sole and a thick epidermis that obscures the multilayered dorsal scales. Few *Psolus* species have true cup ossicles, their functional role often being replaced by multi-layered grains (e.g., *P. neozelanicus*) or concave spinous plates. *Psolus ephipiffer* Thomson, 1876 and *P. paradubiosus* Carriol and Féral, 1985 both from the Kerguelen region, have shallow cup-shaped ossicles, but differ from the current species in their body form, large dorsal scales and the knobbed ventral plates. *P. koehleri* Vaney, 1914 from the Antarctic Peninsula has shallow cups in the sole, but has an upturned oral cone, the mouth being surrounded by five brood sacs.

Order Apodida

Chiridotidae

Taeniogyrus dunedinensis (Parker)

Plates 4d, 5r–t

Trochodota dunedinensis Parker, 1881: 418.—Dendy, 1896: 26–28, 49–50, pl. 3 figs 1–8.—Mortensen, 1925: 376–381, figs 59–61.—Pawson, 1968a: 24–25.—Pawson, 1970: 46–47 .—McKnight, 1984: 146.

Taeniogyrus dunedinensis.—Rowe, 1976: 204.

? *Trochodota* sp.—Pawson, 1968b: 149.

Taeniogyrus sp. nov.—O'Hara, 1998a: 146.

Material examined. Macquarie Island, shore, 1912, H. Hamilton (AAE), det. Pawson (1968b) as *Trochodota* sp., AM J4725(2); 54°40′S, 159°01′E, 71 m, NZOI stn D10, det. Pawson (1968a), NIWA(4). ANARE 1986 Expedition, BT4, NMV F77775(1).

New Zealand, Stewart Island, Paterson Inlet, 9 m, 12 Jan 1952, NMV F82702(4).

Description of Macquarie Island material. Up to 15 mm long. 10 uniform tentacles, approximately 8 digits per tentacle. Oral disc orientated obliquely. Skin smooth, not papillate, one specimen (BT4) with a few white spots in the anterior body wall formed from clusters of wheel ossicles. Calcareous ring plates narrow, quadrangular, with slight posterior notches.

Body wall ossicles wheels and sigmoid hooks. Wheels slightly hexagonal, up to 0.09 mm long, 6 spokes, continuous teeth around inner rim, 4 teeth across spokes, 5 teeth between spokes (pl. 5r). 1 specimen (BT4) with wheels grouped in anterior clusters, other specimens with sparse scattered wheels. Sigmoid hooks sparsely scattered, twice as long as wheels, to 0.16 mm long, smooth. Tentacle rods abundant (pl. 5t), to 0.12 mm, straight to curved to bent, not branched laterally, a few complex lateral knobs (pl. 5s), tips forked with 2 clusters of knobs.

Colour. Macquarie Island material (in alcohol) light brown. Live Auckland Island material reddish-brown with dark spots at the base of the tentacles (Mortensen, 1925).

Habitat. Auckland and Campbell Island specimens found under stones at low tide (Mortensen, 1925) and in shell/sand (Pawson, 1968a).

Distribution. New Zealand (1–9 m); Auckland, Campbell Islands (1–180 m); Macquarie Island (65–433 m).

Remarks. The present specimens differ from typical *T. dunedinensis* material from New Zealand in the relative size of the wheel and sigmoid hook ossicles, the wheels being considerably smaller than the hooks. However, the wheel ossicles are known to vary in size from 0.053 to 0.16 mm dia. in other material referred to *T. dunedinensis* (Mortensen, 1925). Without a large number of specimens it is impossible to determine whether the Macquarie Island material is conspecific with that from New Zealand.

Pawson (1968b) described two specimens of an undetermined *Trochodota* species collected by the ANARE expedition from the north coast of Macquarie Island. Unfortunately the ossicles have decayed, however, other characteristics suggest that it also belongs to this species. The specimens are 23 and 30 mm long, 1.5 mm wide, with ten subequal tentacles, eight digits per tentacle, the terminal digits are longest. The skin is not papillate and the mouth is orientated obliquely. The anterior half of the body of one specimen is filled with female gonads, the eggs are 0.3 mm dia.

Two other *Taeniogyrus* species occur in the Southern Ocean. *T. dendyi* (Mortensen, 1925) is known from northwest of the Auckland Islands (Pawson, 1968b). It is large in size (to 180 mm long), purple-white in colour, with 12–14 digits per tentacle. The skin is covered in papillae containing massed hooks, wheel ossicles are scarce, and the tentacle rods are small (0.05 mm) with 2–5 branches at each end. *T. contortus* (Ludwig, 1875) recorded from Kerguelen, has 12 tentacles, large sigmoid hooks, more than double the size of the wheel ossicles, and wheels that are grouped into distinctive papillae.

Taeniogyrus sp.

Plate 5u, Figure 5b

Material examined. Macquarie Island, AM 1977–1978 Expedition, Green Gorge (15 m), MA-289, AM J22904(3).

Description of Macquarie Island material. Up to 9 mm long (strongly contracted), in poor condition, with tapered anal cone. Skin with numerous longitudinal folds from contraction, probably papillose. Mouth orientated anteriorly, not oblique, 10 uniform tentacles, approximately 4 digits per tentacle, upper 2 largest. Body wall ossicles sigmoid hooks. Sigmoid hooks scattered, 1 per papillae, typically 0.07 to 0.11 mm long (pl. 5u). No wheels present. Tentacle ossicles mostly eroded, remaining pieces are rod ends with 3 terminal denticulations, entire ossicles probably 0.05 mm long (fig. 5b).

Colour. Tan in alcohol.

Habitat. Coarse sand.

Distribution. Macquarie Island (15 m).

Remarks. Chiridotids with sigmoid hooks but without wheel ossicles are generally referred to the genus *Scoliorhapis* H.L. Clark, 1928. However, although these small, poorly preserved specimens lack wheel ossicles they appear closer to *Taeniogyrus dendyi* (Mortensen, 1925) from New Zealand than the type species of *Scoliorhapis, S. theeli* (Heding, 1928) from southern Australia. Both species have groups of sigmoid hooks associated with skin papillae that are present on the anterior part of the animal. *S. theeli* clearly differs from the Macquarie Island material in having C-shaped unbranched tentacle ossicles, whereas wheel ossicles are known to be scarce or even absent in subantarctic specimens of *T. dendyi* (Mortensen, 1925, Pawson, 1968a). Better preserved material is required to finally determine the identity of these specimens.

Discussion

Habitat. Detailed habitat information is only available for Macquarie Island echinoderms collected from rocky shores (0–2 m) or by divers from shallow subtidal waters (0–25 m). The distribution of echinoderms across habitats at these depths is shown in Table 3. No quantitative survey has ever been conducted at subtidal depths at Macquarie Island. Consequently abundance has been estimated from museum collections.

1. Sublittoral fringe (0–2 m). The ecology and zonation of the rocky shores at Macquarie Island has been described by Kenny and Haysom (1962), Bennett (1971) and Simpson (1976). The sublittoral fringe is dominated by the large brown alga *Durvillaea antarctica*. This habitat which is affected by wave surge can range from 0–3 m on the east coast to as deep as 15 m on the exposed west coast (Ricker, 1984). Immediately seaward of *Durvillaea*, the rocks are covered with foliose red algae. A conspicuous but species-poor echinoderm fauna is present in the upper sublittoral, occurring under rocks, in crevices and under the large fronds of *Durvillaea*. Six echinoderm

Table 3. Known habitat distribution of Macquarie Island echinoderms (0–20 m). No habitat information is available for *Taeniogyrus dunedinensis*.

Species	Sublittoral fringe(0–2 m)		Upper sublittoral (2–20 m)			
	Durvillaea holdfasts	Red algal zone	*Macrocystis* beds	*Codium* beds	Rock overhangs	Sand
Cycethra frigida	?	P	P	P	P	-
Porania antarctica	-	-	R	-	-	-
Pteraster affinis	-	-	R	-	-	-
Henricia obesa	-	-	R	R	-	-
Smilasterias clarkailsa	-	-	-	R	R	-
Anasterias directa	R	P	P	P	P	-
Anasterias mawsoni	?	P	P	N	P	-
Ophiacantha vilis	-	-	R	-	P	R
Amphiura magellanica	-	-	P	-	-	-
Pseudechinus novaezealandiae	-	R	P	R	P	-
Pseudopsolus macquariensis	N	N	R	-	-	-
Pseudocnus laevigatus	-	R	P	P	N	R
Trachythyone macphersonae	-	P	P	P	N	-
Taeniogyrus sp	-	-	-	-	-	P

R = rare (all collections with <= 2 specimens); P = present (3–19 specimens); N = locally numerous (at least one collection with > 20 specimens)

species are generally present, the asteroids *Anasterias mawsoni, A. directa* and *Cycethra frigida*; and the holothurians *Pseudopsolus macquariensis, Trachythyone macphersonae* and *Pseudocnus laevigatus*. The first five of these may be abundant. In particular *P. macquariensis* may completely cover rocks at the low tide level. *P. laevigatus* is not common in this zone.

2. *Upper sublittoral* (2–20 m). Habitats at these depths have been described by Lowry et al. (1978) and Ricker (1984). The habitats include 1) exposed rocks and boulders dominated by a canopy of the kelp *Macrocystis pyrifera* often with an understorey of *Desmarestia chordalis*; 2) sheltered rock caves and overhangs covered with sponges, tunicates and hydroids; 3) protected shallow coves and inlets often with mats of the green algae *Codium subantarcticum*; and 4) areas of coarse sand and gravel. The asteroids and holothurians *A. mawsoni, A. directa* and *C. frigida, T. macphersonae* and *P. laevigatus* are common as in the sublittoral fringe, but *P. macquariensis* is rarely found below 1 m. Several shelf species are also present. The echinoid *Pseudechinus novaezealandiae* and the ophiuroid *Ophiacantha vilis* may be locally common. The asteroids *Henricia obesa, Smilasterias clarkailsa, Porania antarctica, Pteraster affinis*, the ophiuroid *Amphiura magellanica* and the holothurian *Taeniogyrus* sp. also reach their upper limit in this zone.

3. Deep water (< 20 m). The continental slope surrounding Macquarie Island is covered by very little sediment (Williamson, 1988). The slopes are very steep, the east side plunges over 5000 m from Macquarie Island to the Macquarie Trench in a little over 25 km. The total submerged area of the Macquarie Ridge occurring at depths of less than 1000 m deep is only 3300 km^2 (Williams, 1988). Most of the Macquarie Island material from deeper water has been trawled and lacks detailed substratum information. The lack of sediment indicates that many species would occur on rock or amongst sessile invertebrates growing on rock, although there are some species that are known from elsewhere to prefer a soft sediment substratum (e.g., *Psilaster charcoti, Taeniogyrus* spp.).

The echinoderm fauna is similar at all shallow water sites that have been examined around the island (Table 2) although relative abundance can vary with exposure (Bennett, 1971; Ricker, 1984). There are some exceptions. *Porania antarctica* and *Pteraster affinis* have been found by divers only at Caroline Cove despite the low level of sampling at the site. *Taeniogyrus* sp. was collected only at Green Gorge off a sandy substratum. Relatively few soft sediment species

have been found from 0–20 m. This may be due to the lack of suitable substratum or the lack of collecting with dredges and boats within this depth range (G.C.B. Poore, pers. comm.).

The shallow subtidal environment is broadly similar at other subantarctic Islands including Marion Island (Beckley and Branch, 1992; Branch et al., 1993), Heard Island (Smith and Simpson, 1985) and Kerguelen (Guille, 1974; Cherbonnier and Guille, 1975; McClintock, 1985), with the exception that the kelp *Macrocystis* is apparently absent from Heard Island. A similar echinoderm fauna is present at all locations. *Anasterias rupicola, Pseudechinus marionis* and *Psendocnus laevi-gatus* dominate the echinoderm fauna at Marion Island, although the asteroid *Anteliaster scaber* and the ophiuroid *Ophiurolepis intorta* can be locally common. Other shallow water species include *Henricia praestens, Pteraster affinis, Porania antarctica* and *Smilasterias scalprifera*. There has been no subtidal SCUBA survey of Heard Island, but beach washed specimens indicate that the asteroids *Anasterias mawsoni, Odontaster meridionalis, Porania antarctica* and *Pteraster affinis* are common (O'Hara, this report). At Kerguelen shallow rocky reefs support *Anasterias rupicola* and *A. perrieri, Henricia spinulifera, Porania antarctica, Pteraster affinis, Cycethra frigida, Pseudopsolus macquariensis grnai, Pseudocnus laevigatus* and *Trachythyone ekmani*. Kerguelen differs from Macquarie Island in having wide sandy bays which support a significant soft sediment fauna.

Systematics and origin. One of the difficulties identifying echinoderms from Macquarie Island is the polymorphism exhibited by many species (or species complexes) that are widespread throughout the Southern Ocean. There is considerable morphological variation both between and within isolated populations. Examples of widespread polymorphic species include the asteroids *Odontaster penicillatus* and *Cycethra verrucosa* which can vary in form from subpentagonal to stellate with a range of abactinal spination. In other cases a number of discrete regional or sibling species are currently recognised, such as the numerous *Anasterias* and *Henricia* species. The current and past geography of the Southern Ocean is likely to have promoted regional variation and polymorphism. The break up of the ancient continent of Gondwana would have isolated populations of formerly widespread species, which could then have evolved independently (Palaeoaustral species). Examples include *Psolus neozelanicus* and *P. antarcticus*, very similar species that are now widely separated in the Tasman region and off South America respectively. Overlaying these vicariant patterns are species (Neoaustral species) that have subsequently dispersed eastward across the Southern Ocean by epiplanktonic rafting on the West Wind Drift (H.B. Fell, 1962). Infrequent colonisation of isolated islands would promote regional variation and speciation through founder effects and genetic drift (Palumbi, 1994). Polymorphism has possibly been accentuated by a complex process of colonisation, genetic drift and recolonisation by parental stock. Dispersal by epiplanktonic rafting is restricted to shallow water rocky reef species living amongst kelp holdfasts, the only known transportation vector (O'Hara, 1998a). Species rafting to Macquarie Island from the west probably include *Anasterias* spp., *Cycethra frigida, Trachythyone macphersonae, Pseudocnus laevigatus* and *Pseudopsolus macquariensis*, all of which have been found within kelp holdfasts on Macquarie Island.

The problem for a taxonomist is whether these morphological variants are separate species, subspecies or races. Key (1981) has provided some relevant definitions. Species are populations that are reproductively isolated from all others, where reproductive isolation requires that either no hybrids are found in the field or that such hybrids are infertile. A race is any population within a species that it is convenient to recognise on the basis of characteristic attributes. A subspecies is a special case of a geographical race which has been given a formal trinomial name under the terms of the International Code of Zoological Nomenclature.

The trend in echinoderm systematics over this century has been to synonymise regional forms into polymorphic widespread species. Early researchers, with relatively few specimens at their disposal, described numerous species differentiated by small morphological differences. As more comprehensive collections have become available, the distinction between these nominal species became blurred and many were synonymised or reduced to subspecies (e.g., Fisher, 1940; A.M. Clark, 1962). Later monographs have tended to abandon the use of subspecies as it becomes clear that the morphological variants are not confined to distinct regions (e.g., A.M. Clark and Downey, 1992). However sibling species are known to be common in marine systems

(Knowlton, 1993), and recent research indicates that morphologically similar echinoderm species can be distinguished using reproductive or molecular data (e.g., Bosch, 1989; Hart et al., 1997).

The approach in this work is to follow Key's (1981) recommendations not to designate new subspecific names and retain existing species names for regional variants until we have evidence to the contrary. Thus I have refrained from establishing new subspecies for Macquarie Island variants of *Henricia obesa* and *Odontaster penicillatus*. On the other hand I have retained the nominal species *Anasterias directa, Smilasterias clarkailsa* and *Trachythyone macphersonae* even though they are very close to *A. antarctica, S. scalprifera* and *T. parva* respectively. The final determination of whether these are distinct specific or infraspecific taxa will have to await developmental or molecular research as traditional external morphological characters appear insufficient to resolve the problem. Amongst the numerous pentamerous *Anasterias* species, only *A. studeri* and *A. suteri* can be adequately distinguished from *A. antarctica* on morphological grounds. Other species complexes requiring investigation are *Henricia pagenstecheri/ H. simplex/H. lukinsi* and *H. obesa/H. aucklandiae*. On a global scale *Pteraster affinis* is very close to *P. militaris* from the Arctic, and *Ceramaster patagonicus* is similar to *C. grenadensis* (A.M. Clark and Downey, 1992).

This report retains four species as Macquarie Island endemics: *Anasterias directa, Odontohenricia anarea, Trachythyone macphersonae*, and *Trachythyone nelladana*. In addition other poorly known species listed from Macquarie Island, such as *Ophionyxa* sp. and *Taeniogyrus* sp. may also be endemic. However, in no case is the endemic status certain. *A. directa* and *T. macphersonae* are morphological variants of widespread Southern Ocean species. The poorly known species are likely to be regional variants of New Zealand or deep water species. Only *Odontohenricia anarea* and *Trachythyone nelladana* are completely distinct from their congeners. Both are known from shelf habitats (69–135 m) and as such are likely to have migrated to the recently emergent Macquarie Island via the North or South Macquarie Ridge from New Zealand or eastern Antarctica respectively (O'Hara, 1998a). As such we can expect to collect these species in the future from nearby shelf or ridge localities. The lack of apparent speciation on Macquarie Island is a possible indication of the conservative evolution of echinoderms (H.B. Fell, 1962) or the continuing input of genetic material from neighbouring localities via epiplanktonic or larval dispersal (O'Hara, 1998a).

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